Results of forest insect and disease surveys in the ALGONQUIN REGION of Ontario, 1991

CARRIED OUT BY THE GREAT LAKES FORESTRY CENTRE IN COOPERATION WITH
THE ONTARIO MINISTRY OF NATURAL RESOURCES

C.G. Jones and P.M. Bolan

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RESULTS OF FOREST INSECT AND DISEASE SURVEYS IN THE ALGONQUIN REGION OF ONTARIO 1991

Forest Districts:
Parry Sound, Bracebridge, Algonquin Park,
Pembroke, Minden and Bancroft

C.G. Jones and P.M. Bolan

FORESTRY CANADA
ONTARIO REGION
GREAT LAKES FORESTRY CENTRE

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SURVEY HIGHLIGHTS

This report reviews the more important insect, disease and abiotic conditions encountered during aerial and ground surveys of the forested areas in the Algonquin Region of Ontario in 1991.

The gypsy moth has displaced the forest tent caterpillar as the forest pest with the biggest impact on hardwood forests, 208,483 ha of medium-to-heavy infestation. The area infested by the forest tent caterpillar shrunk to 88,778 ha and further decreases are predicted. Previous large populations of the saddled prominent collapsed and only small numbers were observed. Population increases by the jack pine budworm and spruce budworm caused 51,296 and 11,640 ha of moderate-to-severe defoliation, respectively. The pine false webworm continued to have a significant impact on red pine plantations, again prompting control operations by the Ontario Ministry of Natural Resources (OMNR).

Surveys for Scleroderris canker, especially infection by the European race of the fungus, were again conducted and positive identifications were reported in 11 red pine plantations. A combination of factors caused 22,737 ha of moderate-to-severe oak decline.

Thirty sugar maple health plots, three oak health plots, six Acid Rain National Early Warning System (ARNEWS) plots and the four North American Maple Project (NAMP) plots were re-evaluated.

As in previous years, pests in this report are categorized as follows:

Major Insects or Diseases

capable of causing serious injury to or death of living trees or shrubs

Minor Insects or Diseases

capable of causing sporadic or localized injury but not usually a serious threat to living trees or shrubs.

Other Forest Insects and Diseases (Tables)

These tables provide information on two types of pest:

1) those that are of minor importance and have not been known to cause serious damage to forest trees, and
2) those that are capable of causing serious damage but, because of low population levels or for other reasons, did not cause serious damage this year.

The valuable assistance and cooperation extended to the authors by OMNR during the 1991 field season are gratefully acknowledged.

C.G. Jones
P.M. Bolan

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INSECTS

Major Insects

Pine False Webworm,
Acantholyda erythrocephala (L.)

The pine false webworm continues to have a significant impact on the health of young red pine (*Pinus resinosa* Ait.) and eastern white pine (*Pinus strobus* L.). This pest has a preference for the older foliage, although some damage to the current growth does occur. In 1991 there was a noticeable increase in the amount of current defoliation, a reflection of increased numbers in some areas. Seventeen plantations, 14 red pine and three white pine, ranging in height from 0.5 to 5.7 m were assessed to determine defoliation levels (Fig. 1).

Red pine surveyed in Bancroft District averaged 2.6 m in height and the incidence of trees attacked ranged from 21 to 88%; associated defoliation of the old growth varied from 4 to 61% (Table 1). Average current defoliation of 6 and 20% was recorded on 12 and 61% of the plot trees, respectively, at two of these locations. Twenty-one percent of the 1.5-m trees in a white pine seed orchard sustained a 4% loss of the old foliage.

Assessments in two red pine plantations averaging 2.7 m in height, one in Armour Township, Bracebridge District, and the other in Snowdon Township, Minden District, dislosed that an average of 95% of the trees were affected. Associated defoliation of the old growth averaged 28%.

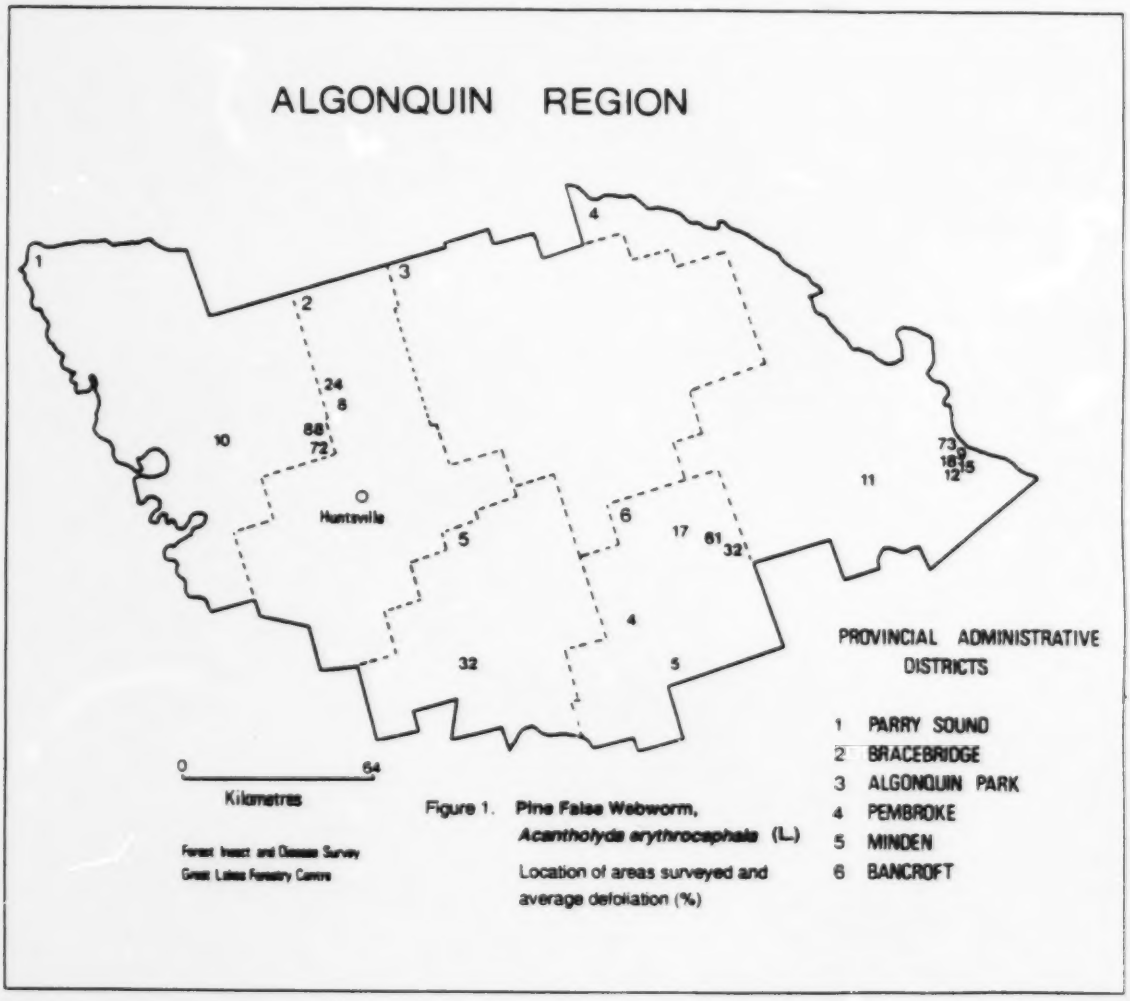


Figure 1. **Pine False Webworm,** ***Acantholyda erythrocephala*** **(L.)**
Location of areas surveyed and average defoliation (%)

Current foliar loss averaged 8% on 35% of the plot trees. A survey of 2.8-m white pine in Armour Township revealed that defoliation of the current growth and old foliage averaged 14 and 8%, respectively, on 4 and 45% of the plantation trees.

High population levels in Parry Sound District were confirmed by two surveys carried out in McMurrich Township, where 100% of the sample was attacked and associated defoliation of the old foliage averaged 88%. Current defoliation in these areas averaged 13% on more than 90% of the sample. At one location in McKellar Township, 13% of the red pine were damaged and old-growth defoliation averaged 10%.

The incidence of attack averaged 42%, with corresponding old-growth defoliation of 14% in four red pine plantations in Horton Township, Pembroke District. Defoliation of the old growth averaged 73% on 99% of the trees and current foliage loss averaged 16% at one other location in the same township. A survey in a white pine seed orchard in Grattan Township found that 3% of the trees were affected and defoliation of old growth averaged 11%.

Control operations against the pine false webworm were carried out by OMNR in a number of red pine plantations using the chemical insecticide Sevin® in the Bancroft, Bracebridge and Parry Sound districts.

Birch Skeletonizer,
Bucculatrix canadensisella Cham.

Medium-to-heavy infestations causing 20 to 100% foliar damage were encountered in numerous stands of white birch (*Betula papyrifera* Marsh.) in the region. A single large body of damage was recorded in parts of each district (Fig. 2).

Table 1. Damage caused by the pine false webworm at 17 locations in the Algonquin Region of Ontario in 1991 (counts based on an examination of 150 randomly selected trees at each location).

Location (Twp)	Tree species[a]	Average height of trees (m)	Estimated trees per ha	Estimated area affected (ha)	Trees affected: new growth (%)	Trees affected: old growth (%)	Average defoliation: new growth %	Average defoliation: old growth %
Bancroft District								
Cardiff	wP	1.5	2,000	4	0	21	0	4
Mayo	rP	5.7	2,000	4	61	88	20	61
Mayo	rP	2.2	2,000	3	12	77	6	32
Monteagle	rP	1.1	2,000	2	0	43	0	17
Wollaston	rP	2.3	1,800	3	0	73	0	5
Bracebridge District								
Armour	rP	2.6	2,500	2	25	99	6	24
Armour	wP	2.8	2,000	2	4	45	14	8
Minden District								
Snowdon	rP	2.8	2,300	5	44	91	9	32
Parry Sound District								
McKellar	rP	0.9	2,200	12	0	13	0	10
McMurrich	rP	3.7	2,500	14	100	100	16	88
McMurrich	rP	3.8	1,800	11	94	100	10	72
Pembroke District								
Grattan	wP	1.1	2,000	4	0	3	0	11
Horton	rP	2.5	2,000	20	69	99	16	73
Horton	rP	2.3	2,000	12	0	46	0	9
Horton	rP	0.5	2,000	8	0	35	0	18
Horton	rP	0.6	2,000	15	0	41	0	15
Horton	rP	0.6	2,000	15	0	47	0	12

[a] rP = red pine, wP = white pine

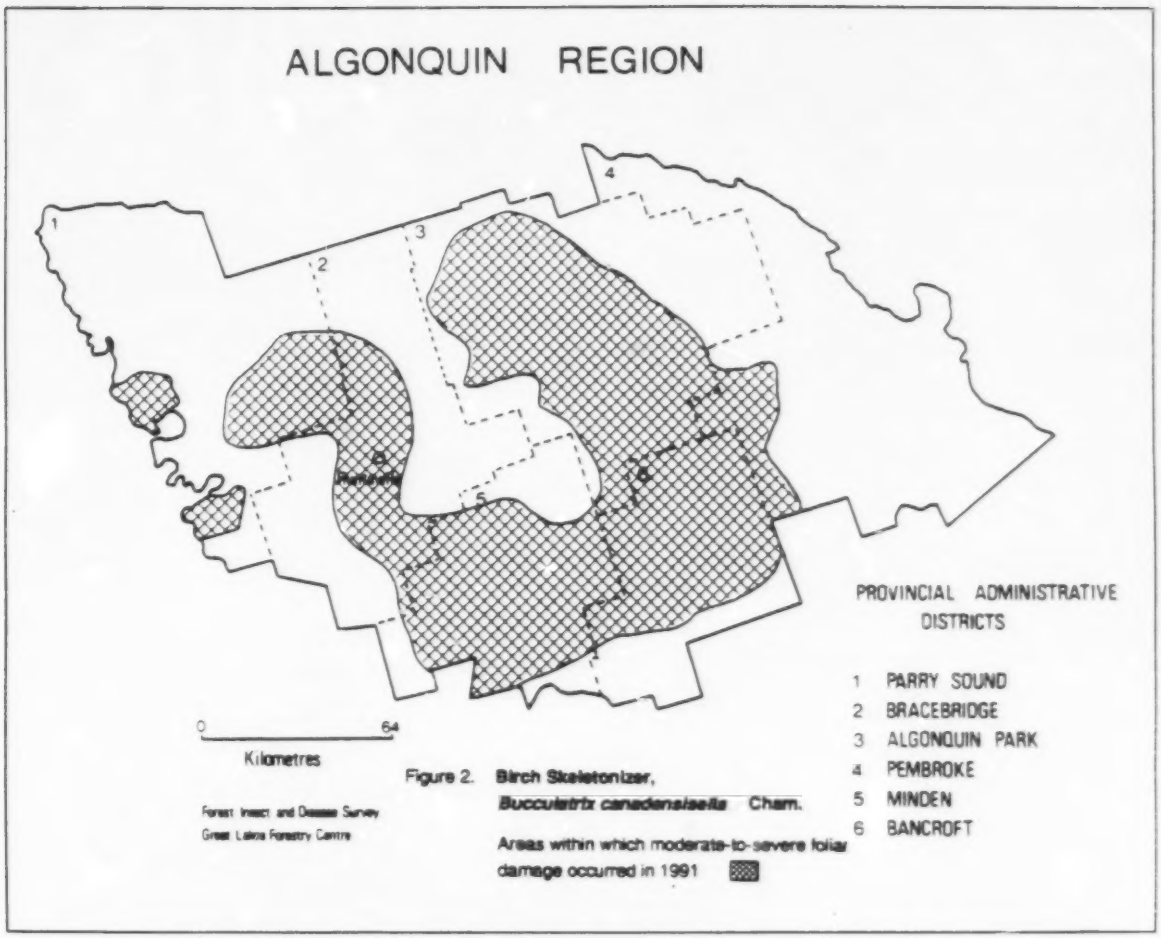


Figure 2. Birch Skeletonizer, *Bucculatrix canadensisella* Cham.

Eastern Spruce Budworm,
Choristoneura fumiferana (Clem.)

Provincial Situation

Spruce budworm populations in the province expanded for the third consecutive year. The area of medium-to-heavy infestation increased from 6,783,261 ha in 1990 to 9,065,781 ha in 1991 (Fig. 3). The main body of infestation was located in the Northwestern and North Central regions and ex- tended eastwards to include parts of the Northern and Northeastern regions. Small pockets of moderate-to-severe damage were also recorded in the Sudbury and North Bay districts in Northeastern Region. Populations continue to expand in Southern Ontario, with increased areas of moderate-to-severe defoliation recorded in Algonquin Region and medium-to-heavy infestations in white spruce (*Picea glauca* [Moench] Voss) plantations in the Central and Southwestern regions.

Associated whole-tree mortality and top kill of balsam fir (*Abies balsamea* [L.] Mill.) and white spruce in the province increased by 638,190 ha, to 3,736,379 ha.

A protection-spray program was conducted by OMNR in the North Central and Northern regions, where 155,140 ha of Crown forests were aerially sprayed with the bacterial insecticide *Bacillus thuringiensis* (B.t.).

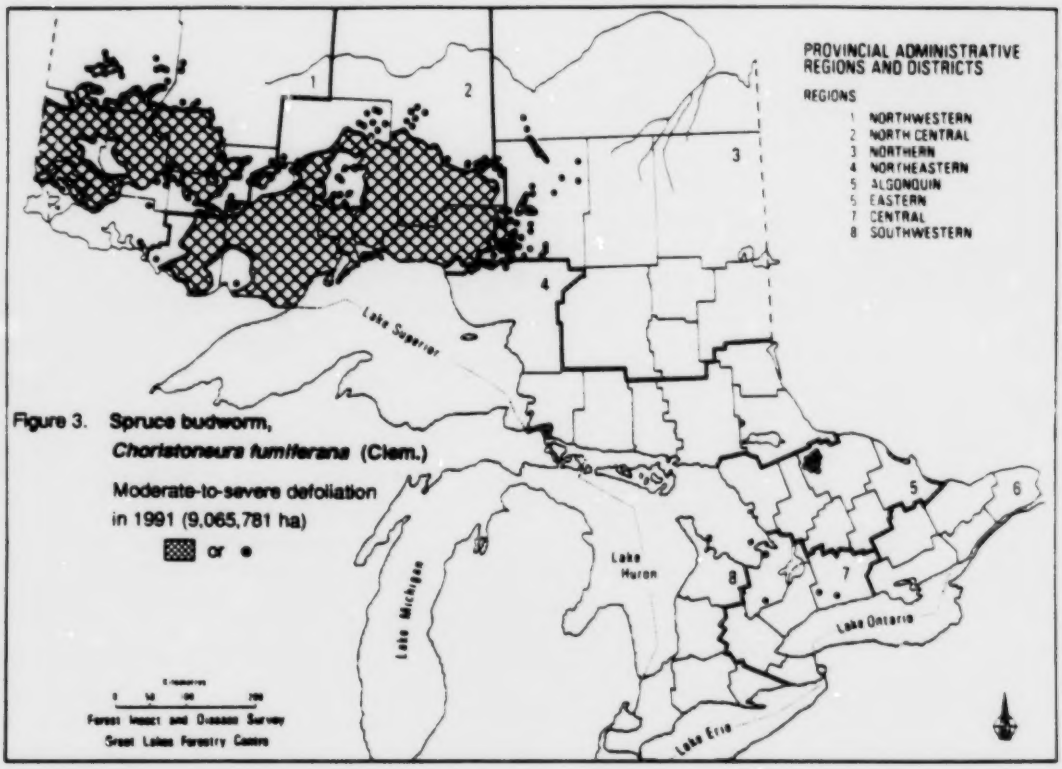


Figure 3. Spruce budworm, *Choristoneura fumiferana* (Clem.)
Moderate-to-severe defoliation in 1991 (9,065,781 ha)
or •

Algonquin Region

Medium-to-heavy infestions that occupied parts of Biggar, Devine and Osler townships, Algonquin Park District, expanded from 2,815 ha in 1990 to 11,640 ha in 1991 (Fig. 4). The infestation continued to be confined to parts of Biggar, Devine and Osler townships. The largest single body of infestation (10,267 ha) occupied the Bouillon-Gibson-Loontail-Coldspring-Wasp lakes area of Biggar and Devine townships.

Egg-mass sampling was carried out at 16 locations in the Region: in Biggar, Devine, Stratton, White and Wilkes townships, Algonquin Park District; in Bethune and Laurier townships, Bracebridge District; in Cavendish, Hindon and Sherborne townships, Minden District; in McMurrich, Mowat and Spence townships, Parry Sound District; and in Alice Township, Pembroke District. Moderate-to-severe defoliation is forecast at three locations, all in Biggar Township (Table 2).

Based on the results of the egg-mass survey and the trend of expansion that occurred the previous year, medium-to-heavy infestations can be expected in 1992 in the same areas, with some expansion and perhaps merging of some of the separate bodies of damage.

In conjunction with the conventional system of egg-mass sampling, groups of three pheromone traps were deployed at six locations. These traps are part of a nationwide program to develop a relatively inexpensive and efficient tool for monitoring spruce budworm populations. The plastic, nonsaturating traps are equipped with a synthetic pheromone and a strip impregnated with a killing agent.The traps are set in place before the adult flight period and are removed in the fall so the contents can be counted. The results of trap catches at locations common to 1990 and 1991 are presented in Table 3. Increased numbers of adults were noted at all locations, even those far removed from

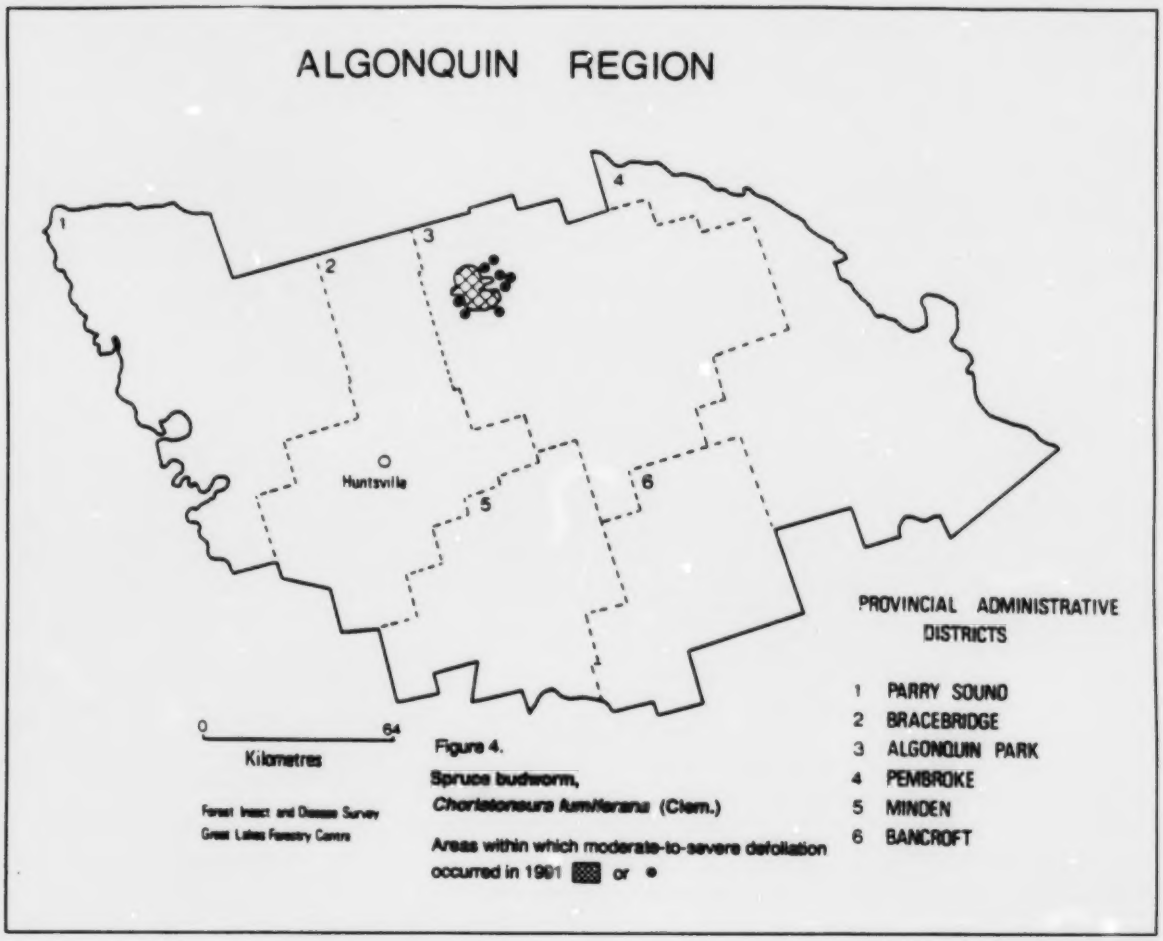


Figure 4.
Spruce budworm,
Choristoneura fumiferana (Clem.)

the current area of infestation, indicating a general population increase for spruce budworm in the region.

Jack Pine Budworm,
Choristoneura p. pinus Free.

Provincial Situation

Significant changes in the area and distribution of medium-to-heavy infestation were recorded in 1991. Across the province, some 133,618 ha of moderate-to-severe defoliation were mapped, a 103,293-ha increase since 1990 (Fig. 5).

Aerial surveys revealed the following total areas of moderate-to-severe defoliation: 71,644 ha in Northwestern Region, 870 ha in North Central Region, 9,808 ha in Northeastern Region and 51,296 ha in Algonquin Region.

Algonquin Region

High population levels of the jack pine budworm were present in Parry Sound District for the second consecutive year (Fig. 6). Parts of the current infested area had also been subjected to five consecutive years of moderate-to-severe defoliation by the jack pine budworm, from 1982 to 1986. Some areas, therefore, experienced only a brief respite from the stress of severe defoliation. Jack pine (*Pinus banksiana* Lamb.) within the area of infestation are, for the most part, growing on shallow, rocky sites, and have been subjected to the addi-

Table 2. Spruce budworm in Algonquin Region: defoliation estimates and egg-mass counts in 1991 and infestation forecasts for 1992.

Location	Host	Estimated % defoliation 1991	Number of egg masses per 9.29 m^2 of foliage	Infestation forecast for 1992[a]	Accumulated damage[b]
Algonquin Park District					
Biggar Twp – Gibson Lake	bF	88	247	S	2
– Gibson Lake West	bF	72	442	S	1
– Loontail Lake	bF	92	1,573	S	2
Devine Twp – Misty Lake	bF	2	0	0	0
Stratton Twp	wS	0	0	0	0
White Twp	bF	0	0	0	0
Wilkes Twp	bF	1	0	0	0
Bracebridge District					
Bethune Twp	bF	0	0	0	0
Laurier Twp	bF	5	0	0	0
Minden District					
Cavendish Twp	bF	5	0	0	0
Hindon Twp	bF	0	0	0	0
Sherborne Twp	bF	5	0	0	0
Parry Sound District					
McMurrich Twp	bF	5	0	0	0
Mowat Twp	bF	5	0	0	0
Spence Twp	bF	0	9	L	0
Pembroke District					
Alice Twp	bF	0	0	0	0

[a] S = severe, M = moderate, L = light, 0 = nil

[b] 0 = undamaged; 1 = light damage, <25% total defoliation, usually one season of severe defoliation; 2 = moderate damage, 25–60% total defoliation, two or three seasons of severe defoliation

Table 3. Spruce budworm moth catches at six locations in the Algonquin Region of Ontario in 1990 and 1991 (counts based on the total number of moths from each cluster of three traps, using the Biolure attractant).

Location	Number of adults trapped 1990	1991
Algonquin Park District		
Stratton Twp	13	633
White Twp	53	622
Bracebridge District		
Bethune Twp	3	530
Minden District		
Hindon Twp	5	140
Parry Sound District		
Spence Twp	0	221
Pembroke District		
Alice Twp	24	782

tional stress of below-normal precipitation for at least 3 years. Tree condition varied within the area of damage: three 100-tree mortality cruises were conducted, two in Wallbridge Township and one in Harrison Township. At one location in Wallbridge Township, there was only 1% tree mortality (last 2 years), while at the other location, 24% of the trees examined were dead and 9% of the sample had bare tops (heavy crown defoliation). Assessment at the Harrison Township location disclosed that 5% of the sample was dead and 33% had bare tops. Jack pine was the primary host, but eastern white pine growing in or near areas of heavily infested jack pine experienced up to 70% current defoliation. Greater defoliation was usually confined to eastern white pine growing under or near the jack pine.

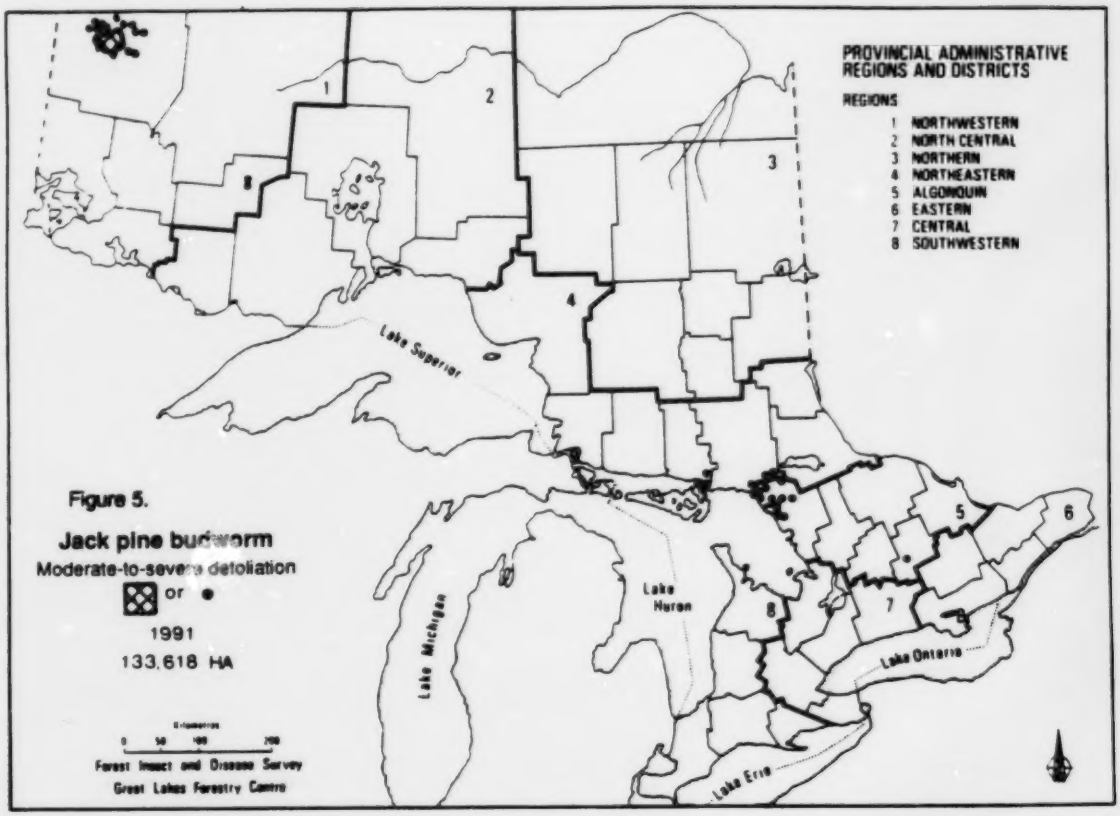


Figure 5.

Observation discerned 10 to 20% defoliation of 16-m eastern white pine and 30 to 70% defoliation of 3- to 5-m trees at a number of locations.

The infestation in Parry Sound District increased from 29,660 ha to 51,276 ha in 1991. The largest single body of damage was located along the Georgian Bay coastline between Henvey Inlet and Pointe au Baril, extending inland. It included parts of Harrison, Wallbridge, Mowat and Henvey townships. Another large infestation was noted in the Island Lake area in Wilson and McKenzie townships. An additional 11 smaller pockets were detected in northern Parry Sound District.

A 20-ha area of moderate-to-severe defoliation was also mapped in a stand of young 10-m jack pine in Methuen Township, Bancroft District.

Egg-mass sampling for the purpose of population forecasting was carried out at 28 locations in the region. Eleven of these locations were in the Algonquin Park and Pembroke districts and no defoliation is expected in these areas in 1992 (Table 4). Medium-to-heavy infestations are forecast at 11 of 15 sample points in Parry Sound District as well as at one of two locations sampled in Bancroft District. Little change is expected for 1992 in the Parry Sound and Bancroft districts. The areas infested in 1991 will be reinfested in 1992, with some possible expansion of the outbreak.

Larch Casebearer,
Coleophora laricella (Hbn.)

Moderate-to-severe foliar damage on native tamarack (*Larix laricina* [Du Roi] K. Koch) was noted at a number of locations in the region. Areas affected ranged from 1 to 5 ha in size and the height of affected trees averaged 15 m. Refoliation had occurred by midsummer in most stands hosting medium-to-heavy infestations.

Surveys conducted in Bancroft District in two stands of 16-m hosts totaling 3 ha, one in Herschel

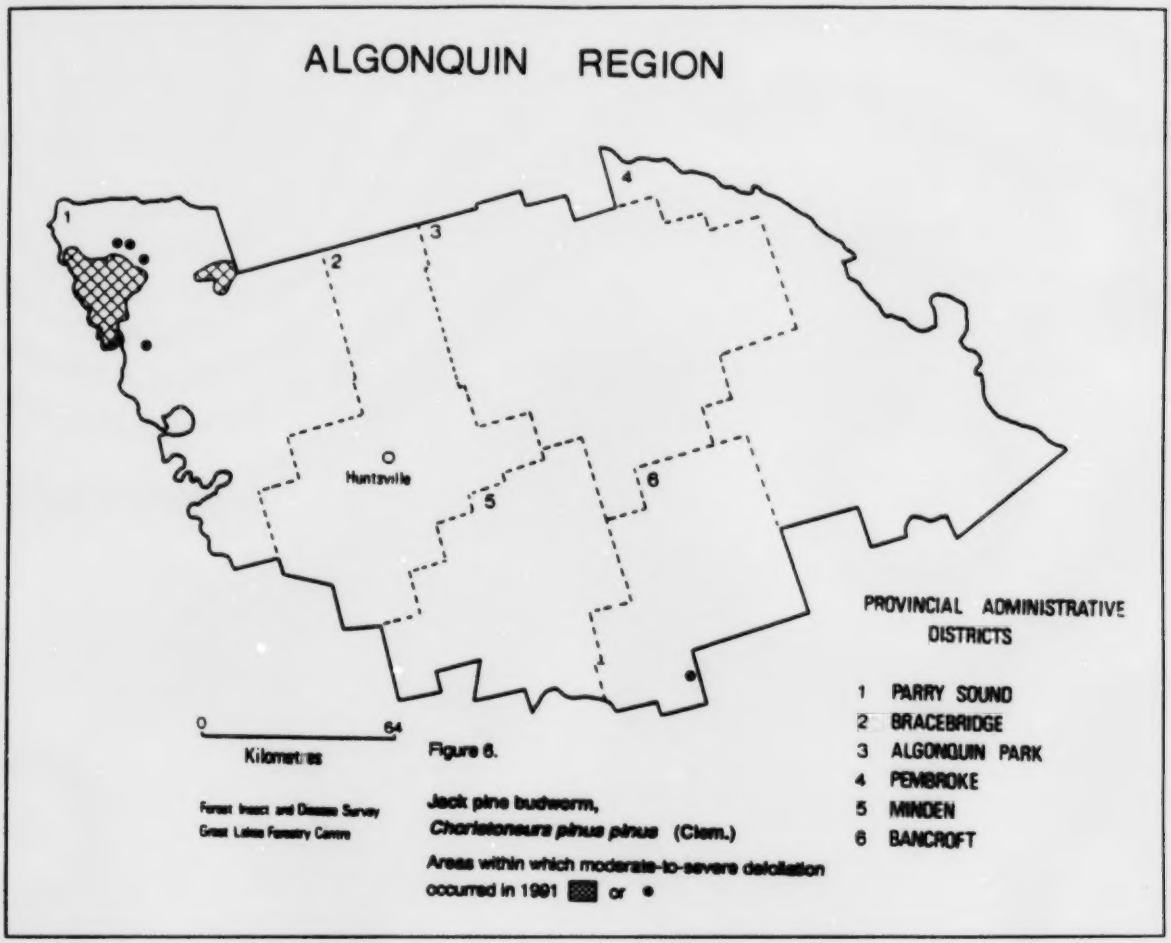


Figure 6.

Township and the other in Wollaston Township, disclosed an average of 65% foliar damage.

Approximately 20 ha of moderate-to-severe foliar damage were detected in Bethune, Draper and Stephenson townships, Bracebridge District. Affected trees ranged from 5 to 15 m in height and associated foliar damage ranged from 20 to 80%.

Surveys revealed about 10 ha of medium-to-heavy infestations in Minden, Snowdon and Somerville townships, Minden District. The affected trees averaged 15 m in height and associated foliar damage averaged 40%.

Assessment at a 3-ha location of 15-m trees in Raglan Township, Pembroke District, disclosed an average of 90% foliar damage.

Saddled Prominent,
Heterocampa guttivitta (Wlk.)

Medium-to-heavy infestations recorded in the Minden and Bracebridge districts in 1990 collapsed in 1991, leaving remnant low levels throughout much of the area previously infested.

Low population levels of the saddled prominent could be found in stands of hardwood hosts, mainly sugar maple (*Acer saccharum* Marsh.), yellow birch (*Betula alleghaniensis* Britton) and beech (*Fagus grandifolia* Ehrh.) at a number of locations in the Region. However, a number of these stands had also experienced light defoliation by the forest tent caterpillar, so that in some areas light-to-moderate defoliation (less than 20%) was

apparent. Small numbers of the saddled prominent feeding in stands initially damaged by low population levels of the forest tent caterpillar resulted in light-to-moderate defoliation in Dysart, Glamorgan, Minden and Monmouth townships, Minden District; in Cardiff, Dungannon and Mayo townships, Bancroft District; and in Lyndoch, Matawatchan and Raglan townships, Pembroke District. Elsewhere in the region, small numbers were noted in host stands in the northern parts of the Bracebridge and Parry Sound districts.

Table 4. Jack pine budworm in Algonquin Region: defoliation estimates and egg-mass counts in 1991 and infestation forecasts for 1992 on jack pine.

Location	Estimated % defoliation 1991	Total number of egg masses on six 61-cm branch tips	Infestation forecasts for 1992[a]
Algonquin Park District			
Edgar Twp	2	0	N
Fitzgerald Twp	5	0	N
White Twp	5	0	N
Bancroft District			
Chandos Twp	4	0	N
Methuen Twp	40	5	M
Parry Sound District			
Blair Twp	9	1	L
Carling Twp – Hwy 69	10	0	N
– Snug Harbour	10	0	N
Harrison Twp – Hwy 529	50	19	H
– Hwy 529A	63	40	H
– Indian Reserve 17A	82	24	H
– Pointe Au Baril	10	3	M
Henvey Twp	53	23	H
Mowat Twp – Pickerel River	5	2	L
– Still River	65	22	H
Wallbridge Twp – Harris Lake Rd	23	5	M
– Magnetawan River	78	45	H
Wilson Twp – Plot 1	86	15	H
– Plot 2	72	23	H
– Plot 3	81	33	H
Pembroke District			
Burns Twp	3	0	N
Clara Twp	5	0	N
Fraser Twp	5	0	N
Head Twp	5	0	N
Maria Twp	5	0	N
Petawawa Twp	5	0	N
Richards Twp	5	0	N
Wylie Twp	5	0	N

[a] N = nil, L = light, M = moderate, H = heavy

Fall Webworm, *Hyphantria cunea* (Drury)

Population levels were generally low in the region, although moderate-to-severe defoliation of host trees such as black ash (*Fraxinus nigra* Marsh.), white ash (*F. americana* L.) and white elm (*Ulmus americana* L.) was observed. Damaged hosts ranged in height from 4 to 15 m, and when moderate-to-high numbers of webworm were encountered, the affected area was usually less than 0.5 ha in size.

Areas of high population levels were noted in Minden District in Monmouth and Stanhope townships, where an average of two or three webs on each 4- to 6-m black ash caused 10 to 20% defoliation, and in Dudley Township, where a 0.5-ha stand of 4-m black ash experienced 90% defoliation. Similar population levels were encountered in Bracebridge District, as indicated by

an assessment in Ridout Township. Here, a 0.5-ha area of 12- to 15-m black ash experienced defoliation as high as 90% but averaging 30%. At one other location in the district, Brunel Township, 20% defoliation of occasional ash trees was recorded.

Elsewhere in the region, defoliation of up to 90% was recorded on scattered individual hosts.

Pine Engraver,
Ips pini (Say)

Whole-tree mortality of small-diameter red pine ranging in height from 0.8 to 2.3 m was observed in a number of plantations in the western part of the region.

The highest incidence of beetle attack occurred in a 3-ha plantation of 1.7-m red pine in Galway Township, Minden District. A survey disclosed that 34% of the host trees were dead, 21% recently (in the past year). A combination of factors such as insect defoliation, site and drought predisposed the trees to attack by *I. pini*. Assessment of 0.8-m trees in Stanhope Township, Minden District, found <1% tree mortality.

This pest was noted at damaging levels in a number of plantations in Parry Sound District. Surveys carried out in a 2-ha plantation of 1.3-m red pine in Christie Township and in a 12-ha plantation of 0.9-m trees in McKellar Township revealed recent tree mortality of 2 and 4%, respectively. The mortality at these two locations was caused by a combination of feeding damage by the pine engraver and the northern pine weevil (*Pissodes approximatus* Hopk.). Other surveys, one each in Christie, Ryerson and Spence townships in 2- and 3-ha plantations ranging in height from 1.3 to 2.3 m, disclosed tree mortality of <1%. Warren's root collar weevil (*Hylobius warreni* Wood) was also a factor contributing to tree mortality at the Spence Township location.

Gypsy Moth,
Lymantria dispar (L.)

Provincial Situation

In all, 347,415 ha of moderate-to-severe defoliation were recorded in the province in 1991, a 269,767-ha increase over the previous year and the largest area of damage ever reported.

Slight decreases in the area of moderate-to-severe damage in the Eastern and Southwestern regions were offset by major increases in the Algonquin and Central regions. Small pockets of medium-to-heavy infestation were also recorded in the Espanola and Sudbury districts of Northeastern Region (Fig. 7).

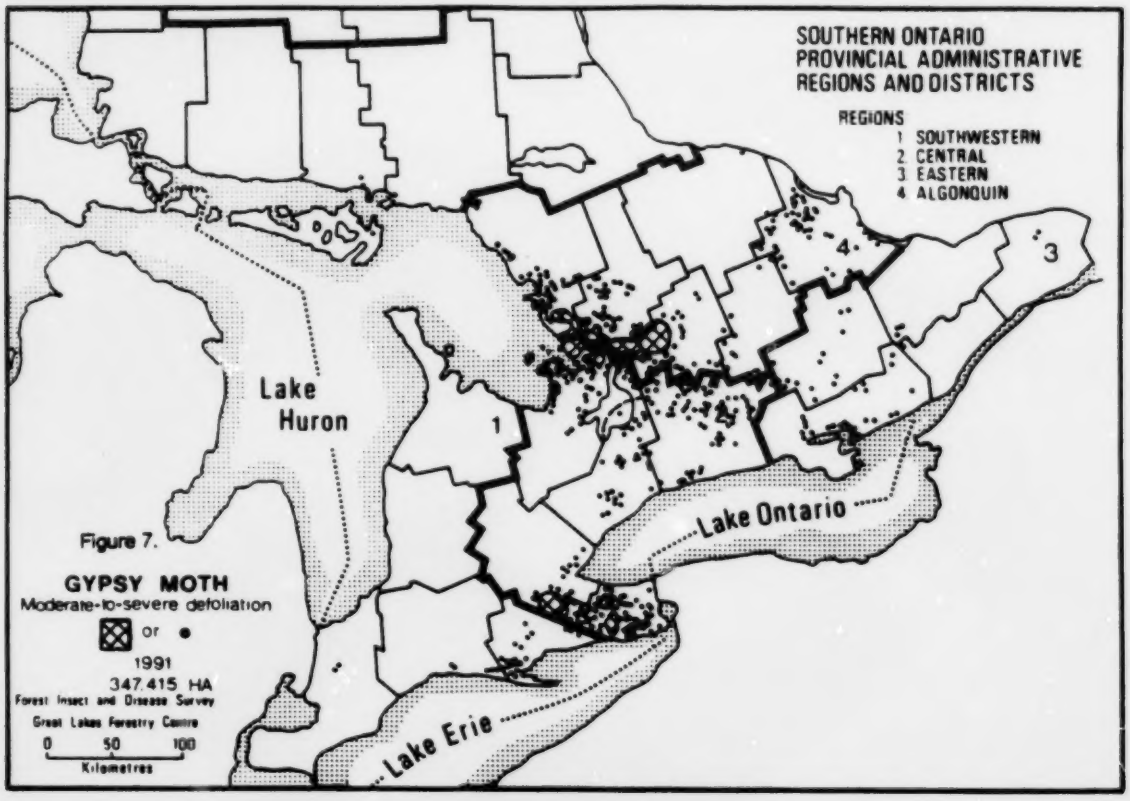
A protection spray program was carried out by OMNR using *Bacillus thuringiensis* in the Carleton Place, Minden, Lindsay, Huronia, Maple, Cambridge, Niagara, Chatham, Simcoe, Pembroke and Parry Sound districts. Approximately 36,577 ha, 5,888 ha of it Crown forests and the rest private land, were aerially sprayed. The spray blocks received two applications at 30 BIU/ha per application.

Algonquin Region

Large increases in the area of medium-to-heavy infestation occurred in five of the six districts in the region; Bancroft District was the exception (Table 5). Over all, the area of moderate-to-severe defoliation increased from 39,235 ha in 1990 to 208,483 ha in 1991 (Fig. 8). Oak (*Quercus* spp.), aspen (*Populus* spp.) and birch (*Betula* spp.) were the most preferred tree species, but moderate-to-severe damage was also encountered on a number of other hardwood hosts.

Moderate-to-severe defoliation of conifers, especially eastern white pine and eastern hemlock (*Tsuga canadensis* [L.] Carr.) growing in stands of preferred hardwood hosts, was also recorded. Current defoliation of individual white pine ranged from less than 5% to 95%. Old-growth defoliation of 99% was also reported.

Surveys in Parry Sound District disclosed 10% old-growth defoliation accompanied by less than 5% current defoliation of 18-m white pine in Carling and Conger townships and 90% defoliation of old growth with 10 to 60% current defoliation of 3- to 15-m white pine in Gibson and Freeman townships. As well, 30% defoliation of old and new



growth of 5-m eastern hemlock was noted in Freeman Township.

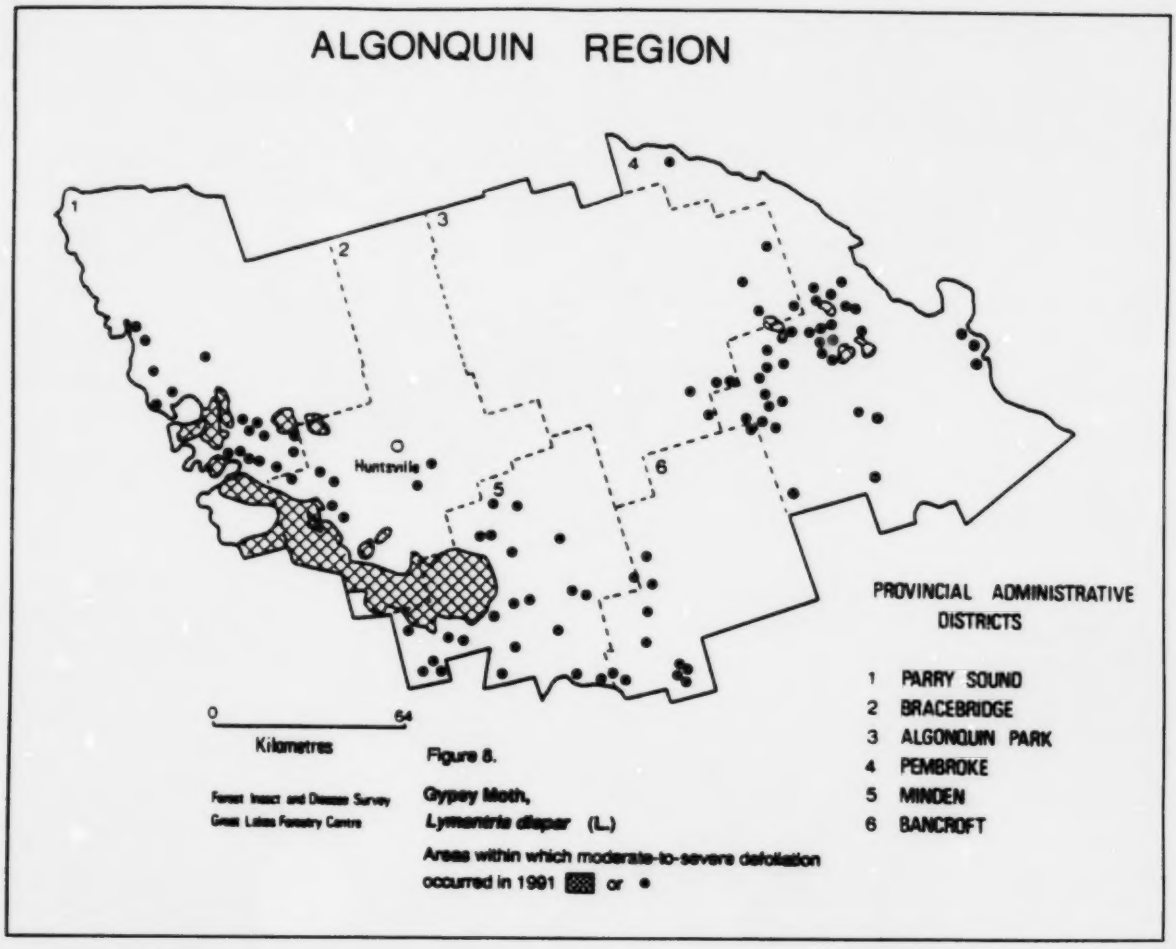
A defoliation assessment of 50 eastern white pine ranging in height from 3 to 15 m was carried out in a mixed stand of eastern white pine and red oak (*Quercus rubra* L.) in Medora Township, Bracebridge District. All crown classes were included in the survey. Defoliation of old foliage was as high as 99%, but averaged 93% over all; current defoliation of up to 95% (suppressed trees) but averaging 52% was also recorded. Surveys at the same location also disclosed 80% defoliation of new and old growth of 12- and 20-m eastern hemlock.

A similar survey was carried out in a mixed stand of red oak and eastern white pine in Ross Township, Pembroke District. Assessment of 25 dominant or codominant white pine averaging 10 m in height disclosed that defoliation of the current year's and previous year's growth averaged 15 and 34%, respectively.

Table 5. Gross area of moderate-to-severe defoliation caused by the gypsy moth in 1990 and 1991 in the Algonquin Region of Ontario.

District	Area of moderate-to-severe defoliation (ha) 1990	1991	Change (ha)
Algonquin Park	172	1,172	+1,000
Bancroft	13,133	6,110	–7,023
Bracebridge	4,359	75,837	+71,478
Minden	5,056	56,163	+51,107
Parry Sound	9,367	52,647	+43,280
Pembroke	7,148	16,554	+9,406
Total	39,235	208,483	+169,248

Dead and diseased larvae infected by the nuclear polyhedrosis virus were found throughout the areas infested by the gypsy moth. Mummified larvae and pupae infected with a fungus



(*Paecilomyces fumosoroseus* [Weize] Brown & Smith) were detected in a woodlot in Medora Township, Bracebridge District.

The pattern of defoliation in 1991 was characterized in part by one large continuous area of medium-to-heavy infestation covering parts of the Minden, Bracebridge and Parry Sound districts. This swath of moderate-to-severe defoliation varied in width from 3 to 25 km and extended from west of Gull Lake, Minden District, to the Georgian Bay coast. It took in parts of Anson, Lutterworth, Longford, Digby and Dalton townships, Minden District; Ryde, Morrison, Oakley, Draper, Muskoka, Wood and Medora townships, Bracebridge District; and Gibson, Freeman and Conger townships, Parry Sound District. Hundreds of smaller pockets of moderate-to-severe damage were also mapped in these three districts, bringing the total gross areas of moderate-to-severe defoliation in the Bracebridge, Minden and Parry Sound districts to 75,837, 56,163 and 52,647 ha, respectively. High population levels in Bracebridge District were recorded as far north as the Lake of Bays-Vernon-Skeleton lakes area and north into Parry Sound District. Pockets of moderate-to-severe defoliation in Minden District were mapped as far north as the St. Nora–Redstone lakes area. Similar damage was recorded in the northern part of Parry Sound District in the Horn–Mary–Mill lakes area and along the Georgian Bay coast to the Pointe Au Baril area.

Low-to-moderate numbers of the forest tent caterpillar were also found feeding in conjunction with large numbers of gypsy moths in Anson, Lutterworth, Longford, Digby, Dalton, Guilford, Hindon and Snowdon townships, Minden District; in Ryde, Oakley, Brunel, McLean, Cardwell and Stisted townships, Bracebridge district; and in Shawanaga, Ferguson and Carling townships, Parry Sound District.

Defoliation in the Algonquin Park, Pembroke and Bancroft districts was typified by scattered pockets of moderate-to-severe defoliation. The area of medium-to-heavy infestation in Algonquin Park District increased to 1,172 ha, up significantly from the 172 ha recorded in 1990. Moderate-to-severe damage was confined to the eastern part of the district, occupying parts of Master, Barron, Dickens, Lyell, Murchison and Stratton townships.

The area of moderate-to-severe defoliation in Pembroke District more than doubled over that of 1990. Some 16,554 ha of medium-to-heavy infestation were reported in the district, mostly in the central part in the Bark–Kamaniskeg–Round–Golden–Clear lakes area.

The 6,110 ha of moderate-to-severe damage reported in Bancroft District in 1991 was less than half the level recorded in 1990. Increased numbers observed in Methuen, Ansthruther and Bangor townships were offset by population reductions in Burleigh Township.

Eastern Tent Caterpillar, *Malacosoma americanum* (F.)

High population levels and accompanying moderate-to-severe defoliation of cherry (*Prunus* spp.) were again observed in the western part of the region in the Bracebridge, Minden and Parry Sound districts, and increases were encountered in Bancroft District. Generally, small numbers of larvae were found in the remaining districts.

Surveys in Dalton, Digby and Laxton townships, Minden District, detected as many as 10 tents per 3-m-high tree and up to 100% defoliation. Elsewhere in the district, observations commonly disclosed one tent per 2-m-high tree and associated defoliation of 30 to 40%. Assessment of 25 3-m-high pin cherry (*Prunus pensylvanica* L.f.) at one location in each of Ryde and Stisted townships, Bracebridge District, revealed an average of three tents per tree and corresponding 90% defoliation. Lower population levels in Parry Sound District were typified by observations made in McMurrich and Monteith townships, where 10 to 30% defoliation of 1- to 2-m cherry trees occurred. Surveys in the southern part of Bancroft District in Burleigh, Cashel, Chandos and Wollaston townships commonly disclosed defoliation of up to 65% on 1- and 2-m cherry trees.

Forest Tent Caterpillar, *Malacosoma disstria* Hbn.

Provincial Situation

The provincewide area of moderate-to-severe defoliation increased from 9,480,408 ha in 1990 to 18,870,508 ha in 1991. Population increases occurred in the northern and northwestern parts of Ontario, while decreased numbers were recorded in the central and southern areas.

Algonquin Region

The area of medium-to-heavy infestation in Algonquin Region decreased by 108,692 ha to 88,778 ha in 1991 (Fig. 9). The intensity of defoliation was also less than in previous years, with much of the current infestion categorized as moderate. Defoliation in many stands ranged from 15 to 30%, with occasional trees in the same stand experiencing 50 to 60% defoliation. A major reason for this limited foliar damage was that although large numbers of caterpillars successfully hatched and progressed to later instars, many were heavily diseased and too sick to feed. Three diseases were commonly recovered in the region, a nuclear polyhedrosis virus, a fungus (*Furia crustosa* [MacLeod & Tyrrell]) and a microsporidian (*Nosema disstriae* [Thomson]).

Oak and aspen were the preferred tree species, but a number of other hardwoods, including white birch and sugar maple, experienced moderate-to-severe defoliation. Medium-to-heavy infestations were recorded in four districts (Table 6).

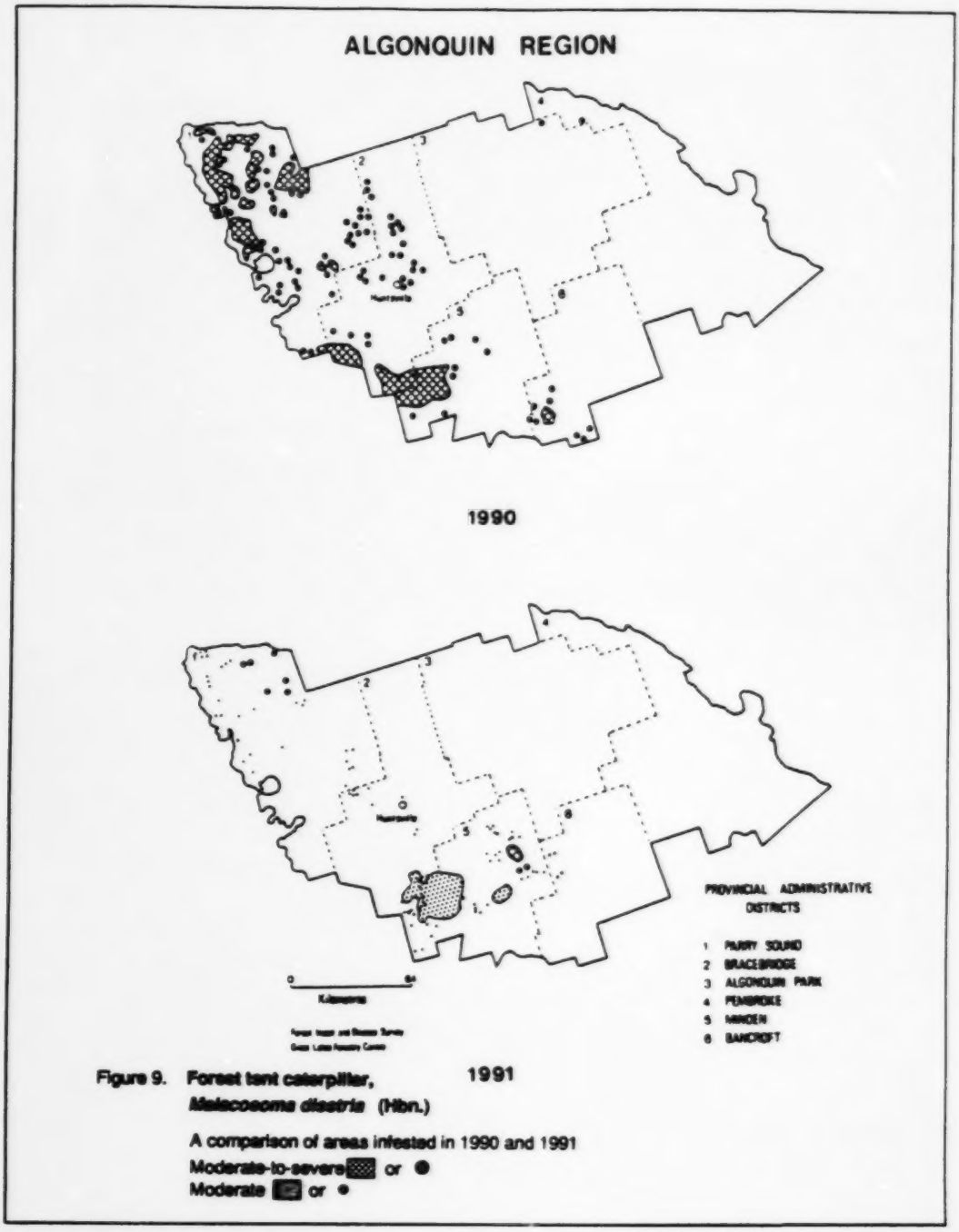


Figure 9. Forest tent caterpillar, *Malacosoma disstria* (Hbn.)

A comparison of areas infested in 1990 and 1991

Moderate-to-severe or ●

Moderate or •

Minden District hosted a population increase and the largest area of moderate-to-severe defoliation, 63,830 ha, the bulk of it moderate. The single most extensive area of medium infestation comprised a 20-km-wide band located west of Gull Lake and occupying parts of Lutterworth, Anson, Longford, Digby and Dalton townships. This same area also hosted large numbers of the gypsy moth.

A number of smaller, satellite pockets of forest tent caterpillar defoliation occurred near this larger body of damage. The next largest body of moderate defoliation was reported north of Highway 503 in the Irondale area, occupying parts of Glamorgan and Snowdon townships. Smaller pockets of medium-to-heavy infestation were also recorded around Haliburton in the Loon–Drag–Haliburton–Redstone–Kennisis–Little Soyers lakes area. A number of these smaller infestations also hosted large numbers of the gypsy moth.

Table 6. Gross area of moderate-to-severe defoliation caused by the forest tent caterpillar in 1990 and 1991 in the Algonquin Region of Ontario.

	Area of moderate-to-severe defoliation (ha)		Change
District	1990	1991	(ha)
Algonquin Park	330	0	–330
Bancroft	5,560	300	–5,260
Bracebridge	39,106	9,272	–29,834
Minden	49,675	63,830	+14,155
Parry Sound	102,714	15,376	–87,338
Pembroke	85	0	–85
Total	197,470	88,778	–108,692

The 15,376 ha of moderate-to-severe defoliation mapped in Parry Sound District comprised mainly moderate damage. Moderate-to-severe defoliation was recorded in the following townships: Carling, Shawanaga, Harrison, Wallbridge, Henvey, Mowat, Blair, McConkey, Brown, Wilson, McKenzie, East Burpee, Ferguson, Spence, Monteith and McMurrich.

Surveys detected 9,272 ha of moderate-to-severe defoliation in Bracebridge District, a 29,834-ha decrease from 1990. Damage was recorded in the southeastern corner of the district in Ryde, Draper and Oakley townships, part of the much larger area of defoliation in Minden District. Additional areas of medium infestion were noted in Cardwell, Stisted, McLean and Brunel townships. A number of the aforementioned areas also hosted high population levels of the gypsy moth.

Four pockets of moderate defoliation totaling 300 ha were delineated in Cardiff and Harcourt townships, Bancroft District.

Further decreases in the area of medium-to-heavy infestation are expected in 1992 based on a combination of factors. Egg-band counts were carried out at eight locations and moderate-to-severe defoliation of hardwoods is predicted at seven of these (Table 7). However, this forecast procedure tends to overestimate defoliation in an aging infestation. Taking into consideration parasitism, overwintering mortality, the presence of smaller and poorly formed egg bands and the widespread presence of viral, fungal and microsporidian diseases, the following forecast can be made (Table 7, Fig. 10).

Table 7. Forest tent caterpillar egg-band counts on trembling aspen at 8 locations in the Algonquin Region of Ontario in 1991 and infestation forecasts for 1992.

Location (Twp)	Average DBH of sample tree (cm)	Number of trees sampled	Average number of egg bands per tree	Infestation forecasts for 1992[a]
Bracebridge District				
Ryde	12.5	3	1	L
Minden District				
Anson	11.3	3	2	M
Dalton	10.2	3	4	M
Hindon	11.5	1	20	S
Snowdon	14.0	2	11	S
Parry Sound District				
Blair	11.3	3	8	S
Mowat	13.0	3	4	M
Wallbridge	11.0	2	13	S

[a] N = nil, L = light, M = moderate, S = severe

Areas of moderate defoliation may persist in Minden District. The largest area of moderate damage, encompassing parts of Anson, Longford, Digby, Lutterworth and Dalton townships, is expected to break up and decrease in size in 1992. Pockets of moderate defoliation may persist in Snowdon and Glamorgan townships as well as in the Loon–Drag–Haliburton–Redstone–Kennisis–Little Soyers lakes area. However, populations will generally continue to de-

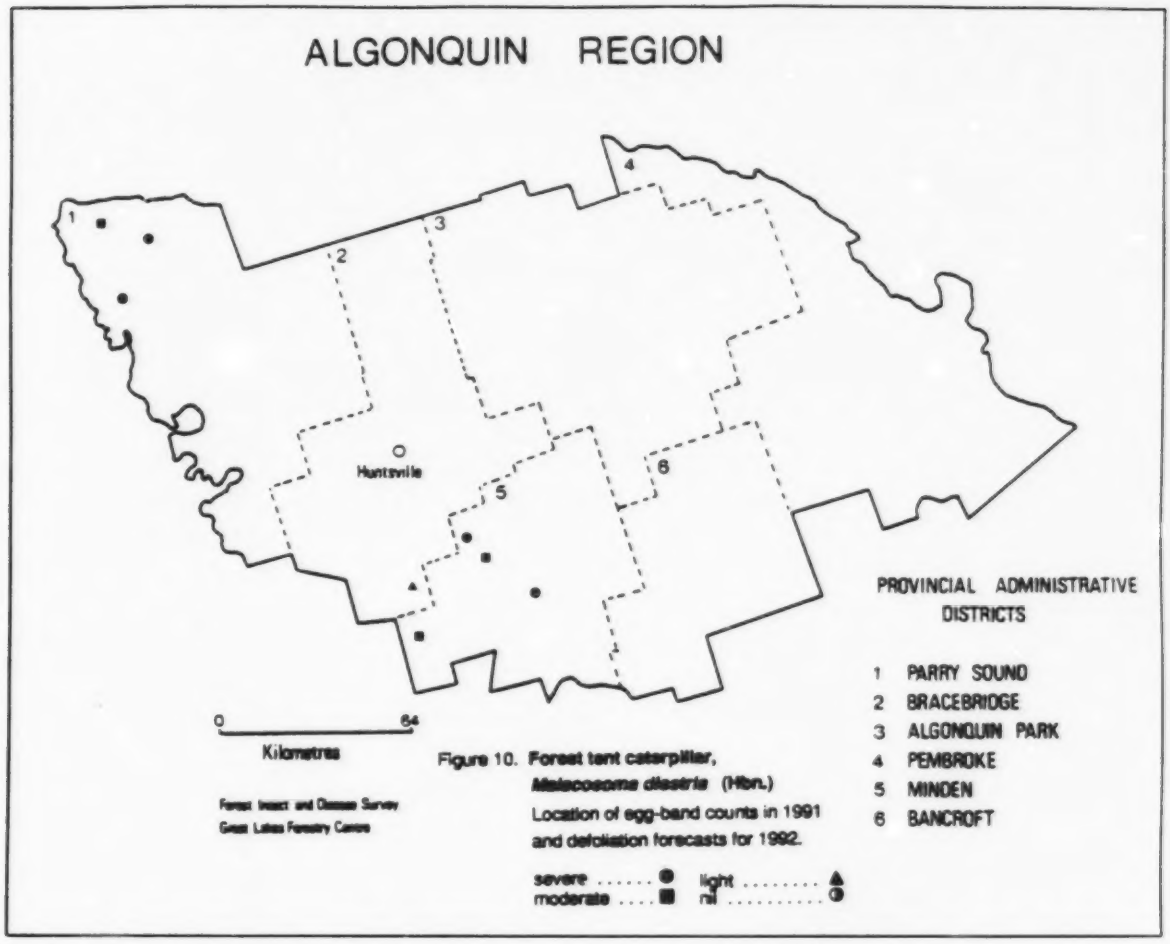


Figure 10. Forest tent caterpillar, *Malacosoma disstria* (Hbn.) Location of egg-band counts in 1991 and defoliation forecasts for 1992.

cline. A further break-up in the area of infestation will occur in Parry Sound District, with some pockets of moderate-to-severe defoliation persisting. Population collapses are probable in the Bracebridge and Bancroft districts.

Balsam Fir Sawfly,
Neodiprion abietis complex

Light-to-medium infestations by the balsam fir sawfly were observed at a number of locations in the region.

The largest area of infestation occurred in Minden District, encompassing Anson, Cavendish, Digby, Dysart, Galway, Glamorgan, Harvey, Hindon, Laxton, Lutterworth, Minden, Snowdon, Somerville, and Stanhope townships. Foliar damage of 15 to 20% confined mainly to the upper crown was recorded on the 10- to 15-m balsam fir hosts in these areas. Foliar damage ranging from 30 to 50% was observed on occasional trees under 10 m in height. In other parts of the region, foliar damage of 15 to 20% was observed on 10- to 15-m balsam fir in Armour, Monck, Morrison, Oakley and Ryde townships, Bracebridge District; in Burleigh, Chandos and Wollaston townships, Bancroft District; in Adamston, Grattan, Lyndoch and Radcliffe townships, Pembroke District; and in McMurrich Township, Parry Sound District.

Damage in the region is more accurately described by two surveys carried out in Minden District. A 100-tree survey in Cavendish Township

of balsam fir ranging in height from 5 to 15 m and averaging 7 m disclosed that 64% of the trees were attacked. Single-tree foliar damage of up to 30% was observed, but overall defoliation averaged 10%. Another survey of 50 balsam fir ranging in height from 4 to 15 m and averaging 9 m was carried out in Glamorgan Township; 60% of the sample was attacked and foliar damage averaged 10%.

Redheaded Pine Sawfly,
Neodiprion lecontei (Fitch)

Population increases in Bancroft District were reflected in surveys carried out at two locations in Monteagle Township. An assessment in a 5-ha plantation of 0.7-m red pine found that 9% of the trees were attacked and associated defoliation averaged 43%. Defoliation of the 1-m hosts at the other area, a 3.5-ha plantation, averaged 26% on 5% of the sample. Single-tree defoliation of up to 90% was noted at both locations. In Bancroft District, OMNR carried out control operations against the pest, spraying 87 ha of red pine plantations with the leconte virus.

Increased numbers of sawflies were observed in the Minden, Parry Sound and Pembroke districts, but no large pockets of moderate-to-severe damage were observed.

Jack Pine Sawfly,
Neodiprion pratti banksianae Roh.

Large numbers of the jack pine sawfly were noted attacking jack pine in the Bracebridge and Minden districts. Trees attacked were open growing and ranged in height from 3 to 12 m.

Surveys in Dalton Township, Minden District, disclosed 100% defoliation of scattered 3- to 10-m trees as well as 40% average defoliation of a group of 40 planted jack pine averaging 9 m in height.

Jack pine was also damaged in Bracebridge District. Defoliation ranging from 30 to 100% was noted in Ryde and Stisted townships on 5-m trees; 90% defoliation of 12-m trees occurred in Wood Township; and 10 to 30% defoliation of 10-m trees was observed in Morrison and Oakley townships.

Yellowheaded Spruce Sawfly,
Pikonema alaskensis (Roh.)

High population levels were again encountered in parts of the region. The moderate-to-severe damage was confined mainly to open-growing ornamental and roadside white spruce ranging from 1 to 4 m in height.

Defoliation of ornamental white spruce 2 to 3 m in height was recorded in Minden District: 99% in Cavendish and Somerville townships, 50 to 80% in Dysart and Stanhope townships, and 20% in Harvey Township. A 25-tree survey of 2-m roadside white spruce in Sherborne Township, Minden District, disclosed that the entire sample was affected and defoliation averaged 15%.

Surveys in Bracebridge District disclosed 70 to 99% defoliation of 1- to 4-m ornamental white spruce in Chaffey, Muskoka and Strong townships.

Defoliation of 1-m roadside white spruce in Sproule Township, Algonquin Park District averaged 35% and up to 50% defoliation of 4-m roadside trees was noted in Wilberforce Township, Pembroke District.

Minor Insects

Introduced Pine Sawfly,
Diprion similis (Htg.)

In 1990, the reported presence of this pest in Armour Township, Bracebridge District, represented a slight northward range extension. It was present in other parts of the region but persisted at low levels. In 1991, however, populations increased and light infestations were recorded in stands of eastern white pine, damaging all age classes throughout the southern parts of the Bracebridge and Parry Sound districts. Commonly, the area infested had also experienced moderate-to-severe defoliation by the gypsy moth.

Ground surveys in Parry Sound District identified light damage along the Georgian Bay coast involving host stands in Carling, Cowper, Conger, Foley, Freeman and Gibson townships. Assessments at a number of sites in these townships dis-

closed 10% or less total defoliation of white pine ranging in height from 1 to 18 m. The area infested by the introduced pine sawfly coincided at a number of locations with the area infested by high population levels of gypsy moth. The moderate-to-severe defoliation of white pine in these areas was caused by gypsy moth.

Similar surveys in Bracebridge District detected small numbers of sawflies throughout host stands of white pine of various age classes in Draper, Morrison, Muskoka and Ryde townships. Total defoliation attributed to the sawfly was 10% or less at most locations. Again, high levels of the gypsy moth and the associated moderate-to-severe defoliation of white pine complicated assessing the exact role of the sawfly in the damage in some areas.

Table 8. Other forest insects.

Insect	Host(s)	Remarks
Croesus latitarsus Nort. Dusky birch sawfly	wB	Observation disclosed 5% defoliation of 2-m trees at one location in Ryde Township, Bracebridge District.
Gonioctena americana (Schaeff.) American aspen beetle	tA, bPo	This beetle caused up to 90% defoliation of young balsam poplar (*Populus balsamifera* L.) throughout Cardiff, Dungannon, Faraday, Herschel and Mayo townships, Bancroft District, and Sebastopol Township, Pembroke District. Small numbers caused 5% defoliation of 2-m trembling aspen in Ryde Township, Bracebridge District, and Dalton Township, Minden District.
Neodiprion n. nanulus Schedl. Red pine sawfly	rP	Light (<5%) defoliation, was noted in red pine plantations ranging in height from 1 to 6 m in Ryerson Township, Parry Sound District, and Minden Township, Minden District.
Oligonychus ununguis (Jac.) Spruce spider mite	wS	Ornamental white spruce 0.5 to 16 m in height experienced up to 100% foliar damage in Canisbay Twp, Algonquin Park District, and 10% defoliation in Richards Twp, Pembroke District.
Pissodes strobi (Peck) White pine weevil	wP	Assessment disclosed 5% of the 2.8-m trees were attacked in a 2-ha plantation in Armour Twp, Bracebridge District.
Plagiodera versicolora (Laich.) Imported willow leaf beetle	W	This beetle caused up to 90% skeletonizing of stands throughout Pembroke District.
Rhynchaenus rufipes (LeC.) Willow flea weevil	W	Foliar damage of 5 to 90% was encountered on ornamental trees in the towns of Madawaska, Rolphton, Deep River, Whitney and Bancroft for the second consecutive year.

TREE DISEASES

Major Diseases

Armillaria Root Rot,
Armillaria ostoyae (Romagn.) Herink

Infections by this root-rot fungus caused recent tree mortality in 10 red pine plantations in the Bracebridge, Minden and Parry Sound districts. Trees in the affected plantations ranged in height from 0.6 to 1.7 m and the incidence of infection was 1% or less. Three of the affected plantations occurred in McMurrich Township and four in Ryerson Township, Parry Sound District. The fungus was recovered from one plantation in each of Perry and Ryde townships, Bracebridge District, and Stanhope Township, Minden District.

Scleroderris Canker,
Gremmeniella abietina (Lagerb.) Morelet

In all, 98 red pine plantations ranging in height from 0.3 to 7 m were surveyed in 1991 to determine the presence and distribution of the North American race and the more virulent European race of the Scleroderris canker fungus (Table 9). Serological testing confirmed the presence of the European race at 11 locations, one of which also harbored the North American race (Fig. 11). The North American race was found by itself at four locations. Although the frequencies of occurrence of both races appear to have increased, no significant spread was recorded.

All of the plantations in which the European race was found (three in Mayo Township, Bancroft District, five in McMurrich Township and two in Ryerson Township, Parry Sound District, and one in Stephenson Township, Bracebridge District) were in townships with a previous history of this race.

Five red pine plantations averaging 2.1 m in height in McMurrich Township, Parry Sound District, were found hosting the European race at an incidence of 1% or less at the following locations: Woodlot Improvement Areas (WIA) No. 178, Concession II, Pt. Lot 22; WIAs No. 135, 137, 139 and 140, Concession II, Lots 13 and 14; WIA No. 175, Concession VII, Pt. Lot 14; WIA No. 168, Concession V, Lot 19; and WIA No. 158, Concessions XI and XII, Pt. Lot 9. The disease was also recovered from two plantations averaging 2.1 m in height in Ryerson Township, Parry Sound District: WIA No. 167, Concession X, Lot 26, and WIA No. 73, Concessions IX and X, Lots 29 and 30. The latter plantation also contained the native race of the fungus.

Less than 1% of the 1.3-m trees in a 10-ha plantation in Stephenson Township, Bracebridge District, were affected by the European race of the fungus.

Three red pine plantations averaging 4.1 m in height in Mayo Township, Bancroft District, were found hosting the European race, two at an incidence of < 1% and one at 3% at the following locations: Concession XIV, Lot 25; Concession XV, Lot 26 and Lot 24; and Concession XIV, Lot 24, respectively.

The North American race was recovered by itself from four red pine plantations averaging 10 ha in size and 1.8 m in height. Surveys determined that the incidence of infection and of recent tree mortality caused by the fungus were less than 1% at the following locations: Concession XIV, Lot 20, Strong Township; Concession XI, Lot 14, Perry Township; and Concessions X and XI, Lot 9, Joly Township, Bracebridge District; and WIA No. 138, Concession X, Lot 20, McMurrich Township, Parry Sound District.

Table 9. Results of a special survey for Scleroderris canker at 98 locations in the Algonquin Region of Ontario in 1991 (counts based on an examination of more than 500 red pine trees at each location).

Location (Twp)	Tree height (m)	Total trees per hectare	Total area examined (ha)	Trees affected (%)	Trees dead (%)
Algonquin Park District					
Airy	0.7	1,800	3	0	0
Airy	2.5	1,800	2	0	0
Airy	3.4	2,000	0.2	0	0
Fitzgerald	0.7	1,800	1	0	0
Nightingale	3.0	2,000	0.1	0	0
Nightingale	0.7	1,800	5	0	0
White	0.6	1,800	3	0	0
Bancroft District					
Burleigh	3.1	2,200	2	0	0
Faraday	2.3	2,000	5	0	0
Mayo	1.0	2,000	2	0	0
Mayo	6.0	2,000	3	0	0
Mayo	4.2	2,000	2	1	0
Mayo	2.0	2,000	3	0	0
Mayo	5.5	300	0.1	<1	0[b]
Mayo	0.9	1,800	6	0	0
Mayo	0.8	2,000	4	<1	0[b]
Mayo	1.1	2,000	2	0	0
Mayo	6.0	1,000	0.4	3	0[b]
Monteagle	0.5	2,000	6	0	0
Monteagle	3.1	1,800	2	0	0
Monteagle	3.4	2,200	3	0	0
Monteagle	0.5	2,000	3	0	0
Wollaston	2.3	1,800	3	0	0
Bracebridge District					
Armour	2.3	2,500	5	0	0
Armour	2.5	2,500	20	0	0
Joly	1.9	2,500	10	<1	<1[a]
Laurier	1.3	2,500	9	0	0
Macaulay	4.0	2,500	3	0	0
Perry	1.7	2,900	10	<1	<1[a]
Stephenson	1.7	2,200	5	<1	<1[b]
Strong	1.5	200	5	<1	<1[a]
Ryde	1.2	2,900	6	0	0
Ryde	1.2	2,500	10	0	0
Minden District					
Dalton	0.3	2,500	3	0	0
Galway	1.4	1,500	1	0	0
Snowdon	5.0	2,500	3	0	0
Snowdon	2.4	2,500	3	0	0
Snowdon	0.8	2,300	6	0	0
Snowdon	2.4	2,300	5	0	0
Somerville	0.8	2,000	7	0	0
Somerville	0.5	2,000	3	0	0
Stanhope	0.6	2,200	26	0	0
Stanhope	0.8	2,500	6	0	0

(cont'd)

Table 9. Results of a special survey for Scleroderris canker at 98 locations in the Algonquin Region of Ontario in 1991 (counts based on an examination of more than 500 red pine trees at each location) (cont'd).

Location (Twp)	Tree height (m)	Total trees per hectare	Total area examined (ha)	Trees affected (%)	Trees dead (%)
Parry Sound District					
Croft	0.5	2,500	2	0	0
Christie	1.3	2,500	2	0	0
Christie	1.5	2,500	3	0	0
Hagerman	2.8	2,500	5	0	0
McKellar	0.9	2,200	12	0	0
McMurrich	0.8	1,500	8	1	<1[b]
McMurrich	2.0	2,500	15	1	<1[b]
McMurrich	1.9	2,200	10	<1	<1[a]
McMurrich	1.2	2,200	8	0	0
McMurrich	1.5	2,500	5	1	1[b]
McMurrich	2.1	1,600	30	0	0
McMurrich	0.5	2,000	10	1	<1[b]
McMurrich	1.0	2,500	30	<1	<1[b]
Monteith	7.0	2,000	5	0	0
Ryerson	13.0	2,500	8	0	0
Ryerson	1.4	2,500	6	0	0
Ryerson	1.3	2,500	10	<1	<1[b]
Ryerson	2.9	2,500	20	<1	<1[c]
Pembroke District					
Alice	2.3	1,800	1	0	0
Alice	3.8	2,000	0.2	0	0
Alice	1.2	1,800	10	0	0
Bromley	3.6	2,000	10	0	0
Brougham	2.0	2,000	4	0	0
Fraser	1.5	2,000	2	0	0
Fraser	0.7	1,200	2	0	0
Fraser	0.9	2,000	1	0	0
Fraser	1.8	1,500	3	0	0
Fraser	1.4	2,000	2	0	0
Grattan	2.8	1,800	1.5	0	0
Hagarty	1.2	2,000	10	0	0
Hagarty	3.2	2,200	6	0	0
Hagarty	4.0	1,800	6	0	0
Head	1.6	1,800	3	0	0
Horton	2.5	2,200	20	0	0
Horton	3.4	2,200	8	0	0
Horton	2.3	2,000	12	0	0
Horton	0.6	2,000	38	0	0
Richards	1.0	2,000	6	0	0
Ross	5.5	2,200	8	0	0
Ross	5.0	2,200	10	0	0
Ross	2.7	2,000	10	0	0
Sebastopol	2.4	2,000	6	0	0
Sebastopol	0.7	1,000	0.5	0	0
Sebastopol	2.0	2,000	5	0	0

(cont'd)

Table 9. Results of a special survey for Scleroderris canker at 98 locations in the Algonquin Region of Ontario in 1991 (counts based on an examination of more than 500 red pine trees at each location) (concl.).

Location (Twp)	Tree height (m)	Total trees per hectare	Total area examined (ha)	Trees affected (%)	Trees dead (%)
Pembroke District (concl.)					
Sebastopol	3.0	2,000	4	0	0
Sherwood	1.1	2,000	4	0	0
Sherwood	1.0	2,000	5	0	0
Westmeath	3.0	2,200	4	0	0
Westmeath	1.5	2,000	2	0	0
Westmeath	1.0	1,800	0.5	0	0
Wilberforce	2.0	2,000	1	0	0
Wilberforce	1.1	2,000	2	0	0
Wilberforce	1.2	2,000	7	0	0
Wilberforce	3.5	2,200	15	0	0
Wilberforce	0.9	1,800	6	0	0

[a] North American race only
[b] European race only
[c] North American and European strains

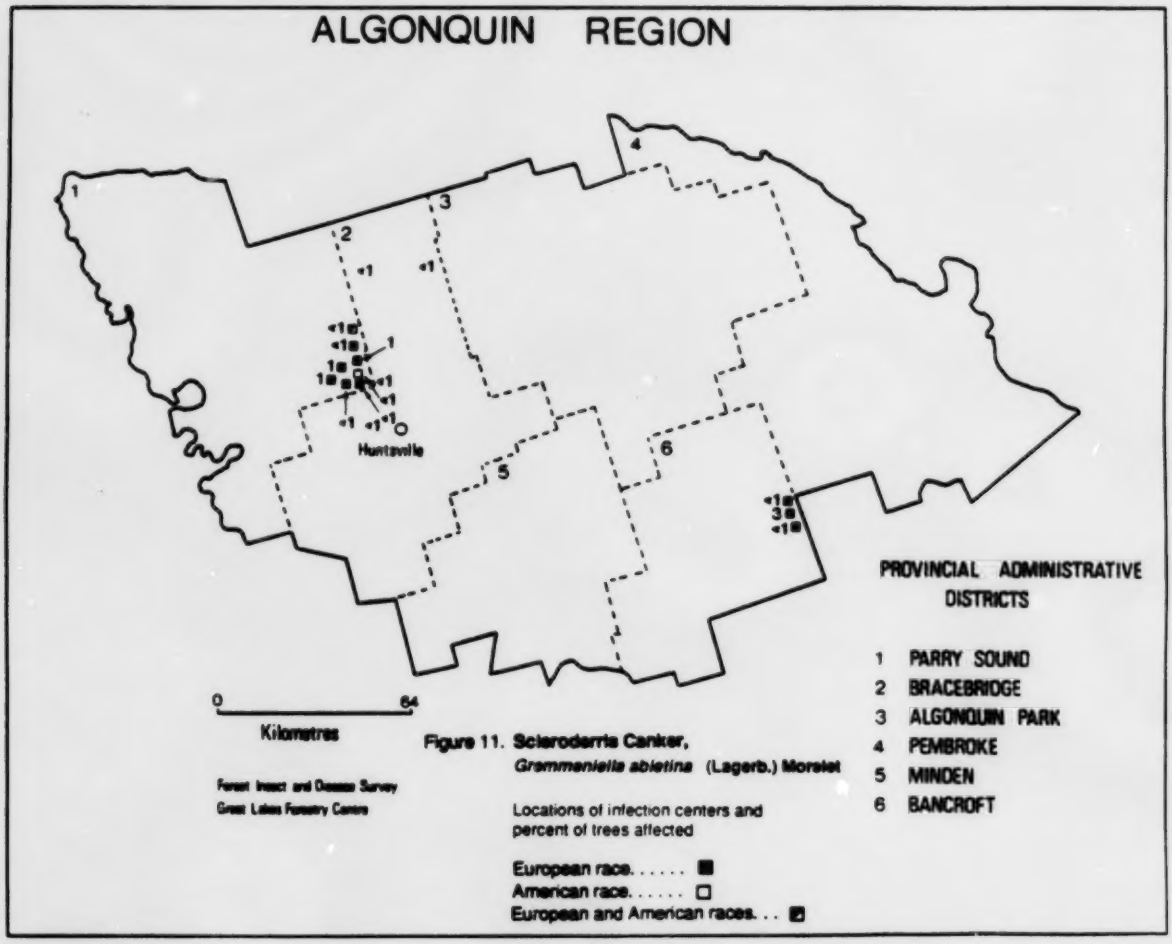


Figure 11. Scleroderris Canker, *Gremmeniella abietina* (Lagerb.) Morelet

Table 10. Other forest diseases.

Disease	Host(s)	Remarks
Cronartium ribicola J.C. Fisher White pine blister rust	wP	The incidence of infection was 5% (3% stem cankers, with 1% recently dead) in a 2-ha plantation of 2.8-m trees in Armour Twp, Bracebridge District. A survey in a 3.5-ha mixedwood underplant of white pine in Lyell Township, Algonquin Park District, found a 38% incidence of infection, with 20% stem cankers.
Verticillium dahliae Kleb. Verticillium wilt	sM	The disease killed 30% of the crown of a 12-m sugar maple in Watt Twp, Bracebridge District.

ABIOTIC DAMAGE

Forest Decline

A combination of factors such as a number of years of below-normal precipitation, medium-to-heavy infestations by the forest tent caterpillar, increasing populations of the gypsy moth and site conditions have had a noticeable detrimental effect on forest health in the region. These stresses have resulted in the decline of a number of tree species, most notably red oak, white oak (*Quercus alba* L.), white birch and eastern hemlock. Aerial surveys detected some 22,737 ha of moderate-to-severe decline and tree mortality of red oak and white oak in the Region (Fig. 12). Ground surveys were also carried out to assess the condition of white birch and eastern hemlock.

Minden District contained the largest area of damage, with 7,177 ha delineated. Extensive areas of decline were mapped in the Catchacoma–Mississauga lakes area in Harvey and Cavendish townships. The oak in this area are mostly open-growing trees on rocky, shallow soils. A 25-tree plot (18 white oak, 7 red oak) was established in 1990 in Harvey Township to rate decline. The plot trees averaged 14.9 m in height and 26.6 cm DBH. At the time of plot establishment, cumulative or total dieback ranged from 5 to 90% and averaged 40%. The decline plot was reassessed in 1991 and it was found that nine trees (36% of the sample) had died over the course of the year. All of the dead trees had 60% or greater total dieback at the time of plot establishment. Total dieback in the current assessment averaged 28%. Armillaria root rot was recovered from seven of the nine dead trees and wood-boring beetles (*Graphisurus* sp. probably *fasciatus* [Deg.]) were found on all the dead trees. A 50-tree mortality cruise was carried out in the same stand in 1990 and 84% of the oak (five white oak and 45 red oak) were dead. The same trees were surveyed in 1991 and tree mortality in that stand had increased to 90%. Other large areas of decline were mapped in Lutterworth, Dalton and Digby townships. The damaged oak in these areas were also open-growing trees on shallow sites. Pockets of moderate-to-severe decline were also mapped in the northern part of Minden District. A 100-tree mortality count carried out in one of these areas of decline in 1990 in Stanhope Township indicated that 55% of the red oak component, averaging 25 m in height and 38 cm DBH, was dead. A followup mortality cruise in 1991 disclosed that tree mortality had increased to 70%. Again, Armillaria root rot and wood-boring beetles were recovered from a number of recently dead trees.

Some 7,132 ha of moderate-to-severe oak decline were mapped in Bancroft Distict. The majority of the decline and tree mortality (6,745 ha) was located in the Wolf, Buzzard and Coon lakes area of Burleigh and Anstruther townships. A 25-tree red oak decline plot was established in one of these areas in Anstruther Township in 1990. Total dieback of these trees (averaging 16.7 m in height and 23.6 cm DBH) was 26%. Evaluation in 1991 disclosed that three trees (12% of the sample) had died and total dieback increased slightly on the remaining trees, to 28%. A 100-tree mortality cruise in the same stand found that 39% of the red oak were dead, up from the 36% recorded in 1990. Armillaria root rot and bark beetles (*Graphisurus* sp.) were recovered from a number of recently dead

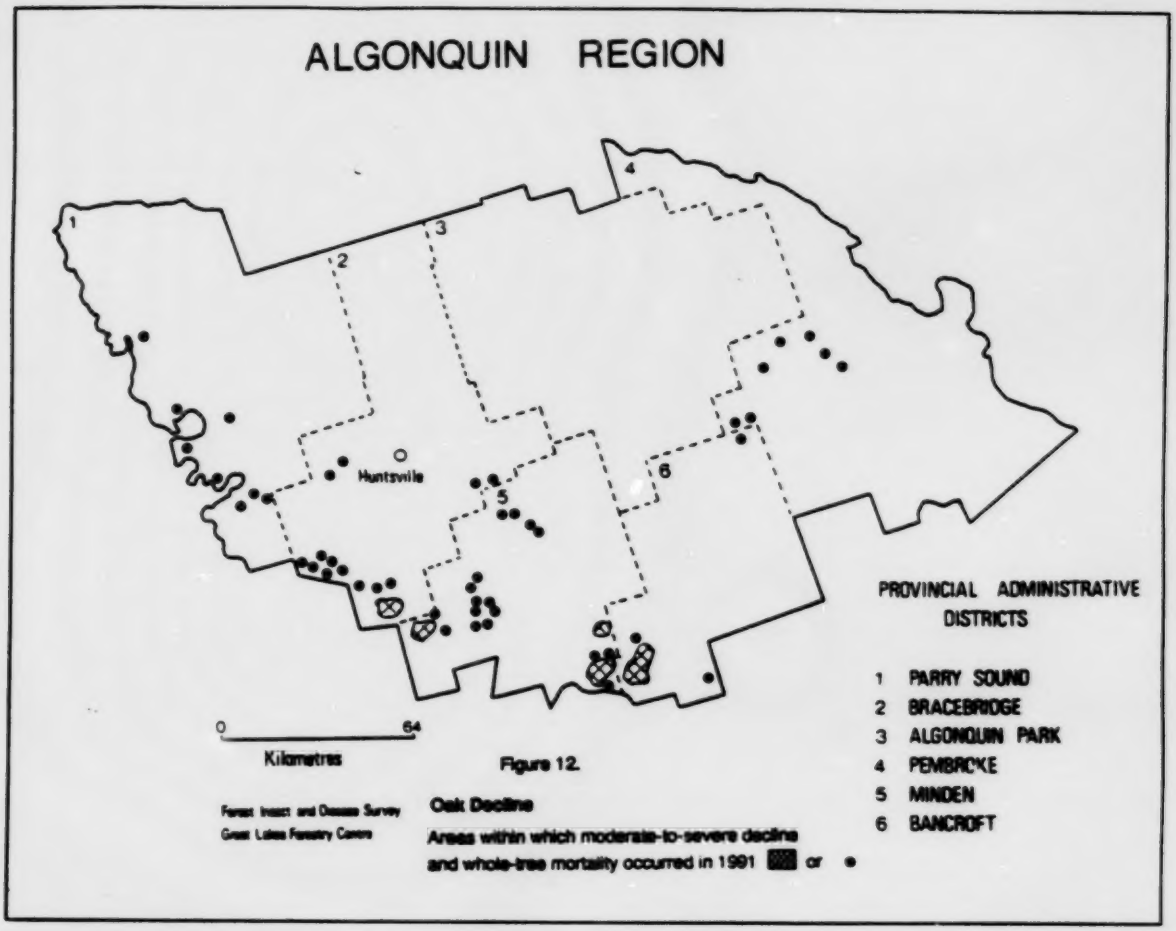


Figure 12.

trees. Additional pockets of moderate-to-severe decline were observed southeast of Anstruther Lake, Anstruther Township, on the northwestern side of Kaminiskeg Lake, Bangor Township, and northeast of Methuen Lake, Methuen Township.

Surveys in Bracebridge District revealed 6,630 ha of moderate-to-severe oak decline and tree mortality. Large areas of damage were mapped in the Kashe–Clearwater–Riley–Ryde lakes area in Morrison and Ryde townships. A 50-tree decline/mortality plot was established in a typical affected stand of red oak north of Riley Lake in Ryde Township. The open-growing red oak averaged 6.2 m in height and 19.3 cm DBH. Assessment revealed that 16% of the 50 trees surveyed had recently died and that total dieback ranged from 10 to 90%, but averaged 55%, on the remaining 42 trees. Other areas of decline were noted in Wood and Muskoka townships.

Additional small pockets of moderate-to-severe oak decline totaling 1,230 ha were noted in Parry Sound District in Carling, Conger, Cowper, Ferguson, Freeman, Gibson, McDougall and Shawanaga townships. Most of the affected oak in these areas are open-growing trees on shallow soils.

Surveys in Pembroke District delineated a number of small pockets of moderate-to-severe oak decline, totaling 568 ha. Most of these trees were found growing on shallow soils in Fraser, North Algona, Richards, Burns, Jones and Sherwood townships.

The combined effects of site, drought and insect infestations also took a toll on white birch,

especially in the western part of the region. Tree mortality of white birch was noted in stands growing on shallow soils throughout the Bancroft, Bracebridge, Minden and Parry Sound districts. Three 100-tree mortality cruises were carried out in stands with a high component of white birch and only recently dead trees (fine branches still attached) were included in the surveys. A 100-tree cruise in Glamorgan Township, Minden District, revealed that 40% of the white birch averaging 14 m in height and 15.4 cm DBH were dead. A similar survey in Mowat Township, Parry Sound District, found 52% of the 14-m hosts had died. Tree mortality was 8% in a stand of white birch averaging 8 m in height and 11.4 cm DBH in Carlow Township, Bancroft District.

Drought-related mortality of eastern hemlock was encountered at a number of locations in the western part of the region. Dead trees were observed in Stisted, Cardwell, Medora, Monck, Draper, Oakley and Ridout townships, Bracebridge District; in Sherborne, Hindon, Lutterworth, Snowdon, Glamorgan and Cavendish townships, Minden District; in Humphrey Township, Parry Sound District; and in Chandos Township, Bancroft District.

Damage from Road Salt

This problem was common wherever susceptible tree species such as red pine, eastern white pine and eastern white cedar (*Thuja occidentalis* L.) could be found in close proximity to heavily traveled routes on which de-icing salt was used. However, buds were not damaged and the production of new foliage later in the summer tended to mask the orange-red discoloration.

FOREST HEALTH

Acid Rain National Early Warning System (ARNEWS)

The six ARNEWS plots in the region are part of a nationwide network of monitoring plots established to detect changes in forest trees, ground vegetation and soil. The plots cover conditions in a variety of stand types. The plot in Sproule Township, Algonquin Park District, consists primarily of red oak; the two plots in Wylie Township, Pembroke District, are in plantations of immature white spruce and Norway spruce (*Picea abies* [L.] Karst.); the Ridout Township plot, Bracebridge District, consists of mature sugar maple and yellow birch; the plot in Sherborne Township, Minden District, is in a mature stand of sugar maple and eastern white pine; and the plot in Mowat Township, Parry Sound District, is in a mixed stand of immature white birch, red maple (*Acer rubrum* L.) and trembling aspen. Certain information, such as branch and crown condition, current insect- or disease-related defoliation, woody-tissue damage, and the occurrence of acid rain symptoms, is collected annually. Ground vegetation is also examined, as certain ground plants are sensitive indicators of changes in soil acidity. There were no visible signs of damage by airborne pollutants in any of the plots in 1991. However, an average of 15% defoliation by the forest tent caterpillar was encountered in the Mowat Township plot in Parry Sound District.

Maple Health

Twenty plots, each comprising 25 semimature or mature sugar maple trees, were randomly established in 1987 to monitor tree health in stands with a heavy sugar maple content. One plot has since been dropped and another was established in 1991. The crown condition of each tree was rated up to 1991 with a dieback classification that evaluated current and total dieback in five categories: 0 = 0–5%, 1 = 6–20%, 2 = 21–40%, 3 = 41–60%, 4 = >60%, and 5 = dead tree (Table 11). In 1991, only cumulative dieback was assessed and comparisons with previous years are included in Table 11.

Table 11 indicates that, over all, 92% of the sugar maple had 20% or less cumulative dieback and 2% of the living trees had >40% total crown dieback. Since plot establishment, 14 trees have died, including six more since 1990.

Table 11. Maple health data from 20 plots established in the Algonquin Region of Ontario (counts based on an examination of 25 sugar maple trees at each location).

Location (Twp)	Average DBH (cm)	Year	Cumulative dieback class[a] 0	1	2	3	4	5	Trees blown down or cut
			← Number of trees →						
Algonquin Park District									
Deacon	32.5	1987	0	3	18	4	0	0	0
		1988	0	3	16	6	0	0	0
		1989	0	16	8	1	0	0	0
		1990	0	13	12	0	0	0	0
		1991	11	14	0	0	0	0	0
Peck	36.3	1987	0	4	17	4	0	0	0
		1988	0	5	16	4	0	0	0
		1989	0	13	11	1	0	0	0
		1990	0	20	3	0	1	1	0
		1991	18	5	0	0	1	1	0
Murchison	41.0	1987	0	9	16	6	0	0	0
		1988	0	9	16	0	0	0	0
		1989	0	21	4	0	0	0	0
		1990	0	23	2	0	0	0	0
		1991	24	1	0	0	0	0	0
Wilkes	40.5	1991	20	5	0	0	0	0	0
Bancroft District									
Bangor	44.9	1987	0	6	13	6	0	0	0
		1988	0	6	13	6	0	0	0
		1989	0	16	6	1	1	0	1
		1990	0	17	5	1	0	1	1
		1991	13	9	0	1	0	1	1
Cardiff	32.3	1987	0	3	13	9	0	0	0
		1988	0	3	15	7	0	0	0
		1989	1	18	4	1	0	1	0
		1990	1	21	1	1	0	1	0
		1991	22	1	0	0	1	1	0
Limerick	31.8	1987	0	6	16	3	0	0	0
		1988	0	6	16	3	0	0	0
		1989	0	19	6	0	0	0	0
		1990	0	21	4	0	0	0	0
		1991	20	5	0	0	0	0	0
Bracebridge District									
Chaffey	31.6	1987	14	10	0	0	1	0	0
		1988	11	12	1	0	1	0	0
		1989	16	6	1	0	1	1	0
		1990	11	11	0	0	1	2	0
		1991	15	7	0	0	0	3	0
Machar	34.4	1987	12	11	2	0	0	0	0
		1988	9	13	3	0	0	0	0
		1989	3	17	5	0	0	0	0
		1990	0	18	5	1	0	1	0
		1991	5	15	3	1	0	1	0

(cont'd)

Table 11. Maple health data from 20 plots established in the Algonquin Region of Ontario (counts based on an examination of 25 sugar maple trees at each location) (cont'd).

Location (Twp)	Average DBH (cm)	Year	Cumulative dieback class[a] 0	1	2	3	4	5	Trees blown down or cut
			← Number of trees →						
Bracebridge District (concl.)									
Stisted	29.9	1987	10	15	0	0	0	0	0
		1988	2	12	9	2	0	0	0
		1989	1	16	6	1	1	0	0
		1990	0	16	8	1	0	0	0
		1991	3	19	1	2	0	0	0
Wood	31.3	1987	17	7	1	0	0	0	0
		1988	14	8	3	0	0	0	0
		1989	15	8	0	0	1	1	0
		1990	16	7	0	0	1	1	0
		1991	14	9	0	0	0	2	0
Minden District									
Hindon	35.9	1987	9	16	0	0	0	0	0
		1988	7	17	1	0	0	0	0
		1989	11	12	2	0	0	0	0
		1990	9	11	5	0	0	0	0
		1991	11	10	4	0	0	0	0
Minden	41.0	1987	5	12	5	3	0	0	0
		1988	5	15	4	1	0	0	0
		1989	8	16	1	0	0	0	0
		1990	11	13	1	0	0	0	0
		1991	14	11	0	0	0	0	0
Monmouth	30.4	1987	12	11	2	0	0	0	0
		1988	9	12	4	0	0	0	0
		1989	7	12	3	2	0	1	0
		1990	4	13	3	2	0	3	0
		1991	2	17	2	0	0	4	0
Pembroke District									
Richards	40.5	1987	0	10	15	0	0	0	0
		1988	0	7	17	1	0	0	0
		1989	0	16	9	0	0	0	0
		1990	0	20	5	0	0	0	0
		1991	17	8	0	0	0	0	0
Sebastopol	40.2	1987	0	15	9	1	0	0	0
		1988	0	15	9	1	0	0	0
		1989	0	23	1	1	0	0	0
		1990	0	21	3	1	0	0	0
		1991	20	4	1	0	0	0	0
Wylie	37.0	1987	0	5	17	3	0	0	0
		1988	0	4	14	7	0	0	0
		1989	0	15	7	3	0	0	0
		1990	0	17	6	2	0	0	0
		1991	17	5	1	1	0	1	0

(cont'd)

Table 11. Maple health data from 20 plots established in the Algonquin Region of Ontario (counts based on an examination of 25 sugar maple trees at each location) (concl.).

Location (Twp)	Average DBH (cm)	Year	Cumulative dieback class[a] 0	1	2	3	4	5	Trees blown down or cut
			← Number of trees →						
Parry Sound District									
Carling	30.6	1987	25	0	0	0	0	0	0
		1988	24	1	0	0	0	0	0
		1989	21	4	0	0	0	0	0
		1990	20	4	1	0	0	0	0
		1991	21	3	1	0	0	0	0
Christie	31.7	1987	3	14	7	1	0	0	0
		1988	2	16	6	1	0	0	0
		1989	1	13	11	0	0	0	0
		1990	1	19	5	0	0	0	0
		1991	3	17	4	1	0	0	0
Gibson	27.1	1987	15	8	2	0	0	0	0
		1988	16	8	1	0	0	0	0
		1989	18	6	1	0	0	0	0
		1990	18	6	1	0	0	0	0
		1991	12	13	0	0	0	0	0

[a] Dieback classes: 0 = 0–5%, 1 = 6–20%, 2 = 21–40%, 3 = 41–60%, 4 = >60%, 5 = tree dead.

As well as crown dieback, other variables were recorded at the 20 plots in natural stands. Defoliation by the forest tent caterpillar averaged 13% in 20% of the plots and the gypsy moth caused an average of 10% defoliation in three of the plots. Defoliation by the saddled prominent averaged 10% in two plots in Minden District and one plot in Bancroft District. Stem decay, including the presence of fungal fruiting bodies, was observed on 9% of the plot trees. Stem cankers were recorded on 1% of the trees and damage characteristic of the sugar maple borer (*Glycobius speciosus* [Say]) was noted on 3% of the plot trees. Injuries of the main stem, including such things as seams, frost cracks, and open and closed wounds, were found on 54% of the survey trees. Nine additional plots have been established since 1989 to assess crown dieback of semimature or mature ornamental sugar maple in the region. Five of the plots were located in urban areas, one each in Amprior, Beachburg, Eganville, Pembroke and Renfrew. The other five plots consisted of roadside plantings (Table 12). In the five "urban" plots, 89% of the trees had 20% or less total dieback, versus 98% of the roadside trees.

Other problems were recorded in the nine plots. Fungal fruiting bodies, indicators of stem decay, were noted on 5% of the trees and cankers were recorded on 1%. Stem damage in the form of seams, frost cracks, etc. was found on 68% of the trees.

North American Maple Project (NAMP)

As outlined in the 1988 Algonquin Region report, a cooperative project was initiated by the United States Forest Service and Forestry Canada to study the health of sugar maple, with the following objectives:

1. to determine the rate of change in sugar maple tree-condition ratings from 1988 through 1990 (now extended to 1993);
2. to determine if the rate of change in sugar maple tree-condition ratings differed between:
   a) various levels of pollution, measured as wet deposition,
   b) sugar bush and undisturbed forest, and
   c) various levels of initial stand conditions.
3. to determine the possible causes of sugar maple decline and the geographical relation-

ship between the causes and extent of decline. In all, 106 plots were established in the northeastern United States; in Canada, 60 plots were set up in Quebec, Newfoundland, New Brunswick and Nova Scotia.

Ontario was responsible for 24 plots, which were paired in each deposition zone: one was in an undisturbed stand and one in a bush being tapped for maple syrup production. Four plots were in Algonquin Region, one each in Cardiff and Bangor townships, Bancroft District, and in Ridout and Franklin townships, Bracebridge District (Table 13).

Although sugar maple was the primary species of interest, all trees in the plot were examined and the following quantitative and qualitative information was recorded for each: DBH, vigor (five ratings), crown condition, tapping status (sugar maple only), bole quality, location of bole defects, type of bole injury, percentage of crown dieback, foliar transparency and discoloration, dwarfed foliage, and defoliation. This information was

Table 12. Maple health data from five "urban" and five rural roadside plots established in the Algonquin Region of Ontario (counts based on an examination of 25 sugar maple trees at each location).

Location	Plot type	Average DBH (cm)	Year	Cumulative dieback class[a] 0	1	2	3	4	5	Trees blown down or cut
				← Number of trees →						
Bancroft District										
Carlow	rural	60.7	1991	19	3	3	0	0	0	0
Dungannon Twp	rural	67.7	1989	23	2	0	0	0	0	0
			1990	16	9	0	0	0	0	0
			1991	19	6	0	0	0	0	0
Minden District										
Somerville Twp	rural	49.4	1989	7	16	2	0	0	0	0
			1990	7	15	3	0	0	0	0
			1991	18	7	0	0	0	0	0
Pembroke District										
Pembroke	urban	63.2	1989	21	2	1	1	0	0	0
			1990	16	7	1	1	0	0	0
			1991	11	1	1	0	0	0	12
Eganville	urban	54.3	1989	1	11	7	1	0	0	0
			1990[b]	1	13	7	3	1	0	0
			1991	8	10	4	1	1	1	0
Ross Twp	rural	67.1	1989	21	4	0	0	0	0	0
			1990	9	14	2	0	0	0	0
			1991	17	8	0	0	0	0	0
Westmeath Twp	rural	58.3	1989	20	5	0	0	0	0	0
			1990	5	15	4	1	0	0	0
			1991	14	11	0	0	0	0	0
Arnprior	urban	54.8	1990	12	9	4	0	0	0	0
			1991	11	8	2	1	1	0	2
Beachburg	urban	65.6	1990	16	6	3	0	0	0	0
			1991	20	3	2	0	0	0	0
Renfrew	urban	62.4	1990	8	16	10	0	0	0	0
			1991	19	5	1	0	0	0	0

[a] Dieback classes: 0 = 0–5%, 1 = 6–20%, 2 = 21–40%, 3 = 41–60%, 4 = >60%, 5 = tree dead.
[b] Five trees were added to bring the total to 25.

Table 13. Sugar maple crown conditions recorded in four North American Maple Project (NAMP) plots established in 1988 in the Algonquin Region of Ontario.

Location (Twp)	Average DBH (cm)	Year	Number of trees examined	Total percentage of dead crown: 0	1–5	6–15	16–25	26–35	36–45	46–55	56–65	66–75	>76 (Number of trees)	Trees dead	Trees down blown or cut
Bancroft District															
Cardiff[a]	20.2	1988	94	1	54	24	11	2	1	0	0	0	1[c]	0	0
		1989	92	0	28	50	12	2	0	0	0	0	0	2	0
		1990	90	0	38	35	4	6	2	1	3	1	0	4	0
		1991	89	0	35	30	10	5	2	2	2	3	0	5	0
Bangor[b]	37.1	1988	53	0	13	27	11	2	0	0	0	0	0	0	0
		1989	50	0	18	25	6	1	0	0	0	0	0	0	3
		1990	49	0	27	16	3	2	0	1	0	0	0	0	4
		1991	49	0	26	16	5	0	1	0	0	1	0	0	4
Bracebridge District															
Ridout[a]	25.4	1988	61	0	36	15	5	2	1	0	0	0	2	0	0
		1989	59	0	42	10	4	3	0	0	0	0	0	2	0
		1990	56	0	34	19	2	0	1	0	0	0	0	5	0
		1991	56	0	33	19	3	0	0	0	1	0	0	0	0
Franklin[b]	32.3	1988	44	0	32	8	3	1	0	0	0	0	0	0	0
		1989	44	0	29	12	1	1	1	0	0	0	0	0	0
		1990	44	0	25	14	0	2	1	0	0	0	0	0	0
		1991	41	0	21	13	1	4	1	1	0	0	0	0	0

[a] natural forest
[b] sugar bush
[c] One tree had 86–95% total dead crown.

obtained by at least two FIDS rangers. Table 13 compares the results of the three assessments. There was very little change, except for seven new dead trees, two in the Cardiff Township plot, three in the Ridout Township plot and two in the plot in Franklin Township. The plots are relatively healthy considering the stresses that trees in the region have had to contend with; the current survey indicates that >80% of the sugar maple in all four plots had 15% or less cumulative dieback in 1991.

Oak Health

The three red oak plots established in 1977 to monitor changes in crown condition, one in Macaulay Township, Bracebridge District, and one each in Alice and Wylie townships, Pembroke District, were reassessed in 1991 (Table 14).

Some recovery was observed in all three plots in 1991. In the Macaulay Township plot, the Alice Township plot and the Wylie Township plot, 83, 73 and 88% of the trees had less than 20% total dieback, respectively. Since the plots were established, 38 trees (13% of the total) have died.

Gypsy moth defoliation was encountered for the first time in two of the plots. In Alice Township, defoliation ranged from 10 to 95% but averaged 31%. Defoliation averaged 11% in the Macauly Township plot.

SPECIAL SURVEYS

Light Traps

Operation of the light trap at Forestry Canada's Petawawa National Forestry Institute was once more carried out from 6 June to 31 July. The main purpose of this operation was to monitor the flight period of the spruce budworm, although the presence of a number of other major insects was recorded. The number of spruce budworm moths trapped in 1991 decreased to four from the 30 captured in 1990. The number of forest tent caterpillar moths decreased from 897 in 1990 to 133 in 1991.

Climatic Data

Temperature and precipitation have a direct effect on both biotic and abiotic conditions, as can be seen from the occurrence of drought-related forest damage in the region in 1989, 1990 and 1991 (see the section on Forest Decline for details). Table 15 summarizes the weather data for 1991 at two regional stations.

Table 14. Oak health at three locations in the Algonquin Region of Ontario (data based on an examination of 100 host trees at each location).

Location (Twp)	Average DBH (cm)	Year	Cumulative dieback class[a] 0	1	2	3	4	5	Trees blown down or cut
			← Number of trees →						
Bracebridge District									
Macaulay Twp	35	1989	2	54	29	4	0	11	0
		1990	2	52	33	1	1	11	0
		1991	1	72	15	0	0	12	0
Pembroke District									
Alice Twp	18	1989	0	25	53	7	6	5	4
		1990	0	25	51	4	5	11	4
		1991	2	58	14	3	5	14	4
Wylie Twp	25	1989	0	11	65	15	0	9	0
		1990	0	23	59	7	1	10	0
		1991	1	76	9	1	1	12	0

[a] Dieback classification: 0 = 0–5%, 1 = 6–20%, 2 = 21–40%, 3 = 41–60%, 4 = > 60%, 5 = dead tree

Table 15. Summary of mean temperatures and total precipitation at two locations in the Algonquin Region of Ontario in 1991.

Location	Month	Mean temperature (°C) Normal	Mean temperature (°C) Actual	Deviation from normal (°C)	Total precipitation (mm) Normal	Total precipitation (mm) Actual	Deviation from normal (mm)
Bracebridge District							
Muskoka Airport							
	Jan.	−10.4	−10.1	+0.3	85.9	86.2	+0.3
	Feb.	−9.4	−6.8	+2.6	62.4	58.5	−3.9
	March	−3.8	−1.4	+2.4	66.3	120.8	+54.5
	April	+4.5	+6.7	+2.2	73.3	144.8	+71.5
	May	+10.9	+14.3	+3.4	77.8	106.4	+28.6
	June	+15.9	+17.2	+1.3	81.9	71.4	−10.5
	July	+18.3	+18.6	+0.3	77.5	141.7	+64.2
	Aug.	+17.4	+18.8	+1.4	89.0	38.5	−50.5
	Sept.	+13.2	+11.9	−1.3	102.4	120.1	+17.7
	Oct.	+7.5	+8.0	+0.5	93.9	157.2	+63.3
	Nov.	−1.1	+0.5	+1.6	101.0	68.3	−32.7
	Dec.	−7.1	−6.1	+0.1	97.8	89.5	−8.3
Pembroke District							
Petawawa Weather							
	Jan.	−12.8	−13.9	−1.1	46.7	48.9	+2.2
	Feb.	−11.2	−8.6	+2.6	51.0	35.0	−16.0
	March	−4.6	−2.7	+1.9	50.	68.4	+17.9
	April	+4.2	+6.4	+2.2	59.6	85.6	+26.0
	May	+11.5	+14.0	+2.5	60.0	65.8	+5.8
	June	+16.3	+17.7	+1.4	87.5	29.4	−58.1
	July	+18.7	+19.5	+0.8	84.5	61.4	−23.1
	Aug.	+17.6	+18.8	+1.2	79.8	92.1	+12.3
	Sept.	+12.6	+11.3	−1.3	83.1	55.0	−28.1
	Oct.	+7.1	+7.4	+0.3	66.7	114.1	+47.4
	Nov.	−0.1	0.0	+0.1	65.8	44.2	−21.6
	Dec.	−9.7	−9.6	+0.1	64.8	52.0	−12.8